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Intensive Forest Management in Ontario:

SUMMARY OF A 1999 SCIENCE WORKSHOP

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Intensive Forest Management in Ontario:

Summary of a 1999 Science Workshop

F. W. Bell[1], D.G. Pitt[2], M. Irvine[3], W.C. Parker[1], L.J. Buse[1], N. Stocker[3], W.D. Towill[1], H. Chen[1], F. Pinto[1], K. Brown[2], D. DeYoe[1], T. McDonough[3], G. Smith[2], and M. Weber[2]

[1] Ontario Ministry of Natural Resources, Science Development and Transfer Branch

[2] Canadian Forest Service, Great Lakes Forestry Centre

[3] Ontario Ministry of Natural Resources, Forest Management Branch

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Ontario Forest Research Institute
Ministry of Natural Resources
1235 Queen Street East
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Canada P6A 2E5

Telephone: (705) 946-2981
Fax: (705) 946-2030
E-mail: information.ofri@mnr.gov.on.ca

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ABSTRACT

This summary of a 1999 intensive forest management science workshop presents the combined thought and opinions of 24 speakers and close to 180 participants representing provincial and federal government management, science, and operations staff; forest industry; and interest groups from across the province, about the elements of the Ontario Forest Accord that relate to intensive forest management. Summaries of speaker presentations and results of facilitated sessions were used to develop recommendations about what's needed to begin implementing IFM in Ontario.

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Introduction

This report provides summaries of presentations and breakout session discussions from the Intensive Forest Management (IFM) Science Workshop held in Sault Ste. Marie, Ontario in December 1999. The main goal of the workshop was to identify what we know and need to know about IFM to adapt it for use in Ontario's forests. The workshop provided a forum to (1) develop a common level of understanding of the principles, practices, and possibilities for IFM in Ontario, (2) provide managers with a basis for making informed decisions about resource expenditures, and (3) identify education, training, and/or research needs associated with implementing IFM.

In response to commitments made in the 1999 Forest Accord (OMNR 1999b), the workshop was organized to identify science and information needs relevant to:

I. Developing and testing a range of IFM practices

II. Assessing the impacts of IFM on forest growth and yield

III. Directing science activities in support of Ontario's forest-management planning requirements under the Timber Class Environmental Assessment (Timber Class EA) and the Crown Forest Sustainability Act (CFSA)

IV. Modifying existing policies/guidelines, where necessary

V. Enhancing forest protection measures necessary to protect IFM areas from fire, insects, and disease

VI. Assessing the impacts of IFM on the environment

VII. Evaluating the monetary costs and benefits of IFM

The products of this workshop will be used to develop short- (1-2 years) and medium-term (2-5 years) science strategies for the effective and efficient implementation and application of IFM in Ontario. Additionally, working groups or committees will be established to address and guide key elements of these science strategies.

The workshop attracted a total of 204 participants (including facilitators and speakers). Of this, 10 were from out of province: 1 participant from Alberta, and 9 invited speakers from New Brunswick, Quebec, Wisconsin, South Carolina, Washington, and Sweden. The rest of the participants were: 2 members of the Living Legacy Trust board; 61 forest industry staff; 32 provincial science staff; 24 Canadian Forest Service (CFS) science staff; 32 OMNR policy/planning staff; 29 OMNR field staff; 17 people from non-government organizations, academia, and consulting firms; and 7 First Nations representatives (Appendix I). Representation from Ontario was fairly evenly distributed across the 3 OMNR administrative regions, Boreal West, Boreal East, and Southcentral.

In advance of the workshop, participants were provided with background reading, and some suggested definitions of IFM, and related practices (Table 1) as a starting point for discussions.

Table 1. Overview of potential silvicultural practices for consideration in an IFM program for Ontario. (Note: No single practice stands alone; a *series* of practices must be linked into an overall silvicultural strategy that is tailored to site and objectives.)

Preharvest	• Pre-harvest planning • Vegetation management • Wildlife management planning • Stock production planning	• Scarification (for natural regeneration) • Prescribed burning • Tree marking
Harvest	• Tree marking • Harvesting techniques • Commercial thinning • Vegetation management • Improvement cuts (increase value and/or volume) • Selection and shelterwood	• Biomass recovery • Scarification/site preparation • Girdling • Stump treatments (vegetation management; disease management)
Site preparation	• Prescribed burning • Mechanical (e.g., mounding) • Chemical	• Drainage • Fertilization • Soil amelioration (pH, bulk density, organic matter)
Regeneraton	• Stock production • Matching species/population and site • Animal damage control • Seedling quality assessment • Vegetation management	• Fertilization • Spacing • Mycorrhizae • Stock types (exotics, natives) • Irrigation
Tending/ Growth	• Improvement cutting • Vegetation management • Precommercial thinning • Fertilization	• Pruning • Irrigation • Girdling
Protection	• Animal, insect, disease control • Protection - fire, insects, disease • Thinning - precommercial, commercial • Trap trees, pheromone traps • Sanitation (density management)	• Harvest layout • Irrigation • Girdling • Site protection (e.g., compaction, rutting, coarse woody material)
Ongoing	• Growth and yield • Genetics (i.e., tree improvement) • Disease management • Landscape planning	• Effectiveness monitoring • FMP strategy; links and standards • Inventory • Staff training

Key Definitions

Forest management is commonly subdivided into 3 categories (extensive, basic, and intensive), based largely on the rigour with which silviculture is applied (Natural Resources Canada [NRC] 1995; Dunster and Dunster 1996). However, definitions of forest management and silviculture have changed with knowledge and experience as forest managers in Ontario have moved from one management era to another (Appendix II). For example, activities that were considered intensive in the 1970s and 80s may now only be perceived as basic. Indeed, many foresters and others with interests in resource management have their own personal definitions for terms such as basic forest management and intensive forest management. Clearly, each definition is *correct* in terms of the specific context in which it was generated. For the purposes of this workshop, however, the following definitions served as a baseline for discussion:

Forest management, generally speaking, is the practical application of scientific, economic, and social principles to the administration and operation of a forest for specific objectives (Aird 1994).

Silviculture, as a component of forest management, is the theory and practice of controlling the establishment, composition, growth, and quality of forest stands to achieve the objectives of forest management [Natural Resources Canada (NRC) 1995].

Extensive forest management provides protection of the forest from fire and insects and relies largely on unassisted natural regeneration for provision of the next forest. Silvicultural input focuses on attaining a minimum species composition and maintaining a given age-class distribution.

Basic forest management contains all the elements of extensive forest management, but assisted natural and artificial regeneration are used where needed. Objectives are aimed at a normalized forest, by working group, area, and age, with no net change in working group composition over time.

Basic silviculture comprises the practices necessary to establish regeneration of the desired species, free from competing vegetation, within a certain time period. Such practices might include aerial seeding, scarification for seedbed preparation, clearcutting with seed trees, or planting where seed sources are limited (Appendix II). Vegetation management activities are used but are not necessarily timed to maximize crop growth. Free-to-grow is a typical criterion for success.

Intensive forest management combines basic forest management with practices aimed primarily at increasing the value and/or volume of desired forest components (not just timber). Density regulation and genetic improvement are integral parts of IFM.

Intensive silviculture includes the elements of basic silviculture, as well as practices designed to accelerate stand development and improve stand value and yield. Practices may include site preparation, planting of species matched to the site, and vegetation management timed to maximize early growth (Appendix II). Where natural regeneration systems are used, density is regulated through spacing. With increasing levels of intensity, the development of site-specific crop plans and continuous monitoring and feedback mechanisms become important to achieving objectives and fine-tuning processes. As such, intensive silviculture is often characterized by a series of timely interventions during the rotation. When practices such as fertilization, drainage, and/or genetically altered stock are included, the process may be referred to as elite silviculture.

Integrated forest management, or integrated resource management, refers to the forest management process when multiple resources (e.g., timber, wildlife, and recreation) are considered.

Speaker Summaries

The following summaries are condensed versions of presentations made by invited speakers at the workshop. They were produced using a combination of materials provided by speakers, audio cassettes of the presentations, and notes taken during the workshop. These summaries reflect the opinions and thoughts of the individual speakers.

Introductory Session

An Ontario Government Perspective on IFM

Bill Thornton
Director, Forest Management Branch, OMNR
(E-mail: bill.thornton@mnr.gov.on.ca)

Bill provided an overview of how IFM fits into current initiatives in the province, including Ontario's Living Legacy (OMNR 1999a) and the 1999 Forest Accord (OMNR 1999b), some definitions, and what we hope to gain by implementing IFM in Ontario.

Prior to Lands for Life and Ontario's Living Legacy, there were a number of compelling, pre-existing reasons for increased use of IFM. Ontario is Canada's third largest supplier of primary forest products, behind British Columbia and Quebec. In Ontario, 24-25 million m^3 of wood are harvested annually; 89% from crown sources, and the remaining 11% from private land in southern Ontario. Forestry is of tremendous economic and social importance to Ontario. In northern Ontario, there are nearly 50 forest-dependent communities, where the forest industry is the single most important industry. Provincially, forestry accounts for 5 to 6% of manufacturing Gross Domestic Product and 80,000 to 150,000 jobs. Additional secondary manufacturing benefits go primarily to more diversified economies in southern Ontario.

Most of our timber supply is harvested from the boreal forest, but the Great Lakes-St. Lawrence (GLSL) forest is a significant source of high quality hardwood fibre. Ontario's forests do not have an even age distribution, but are weighted towards mature and overmature forest. This has a profound impact on future timber supply, which is undergoing a natural decline. Forest Management Planning guidelines have accelerated this natural decline in wood supply by increasing the land area that is unavailable for harvest. This area currently approximates that set aside as parks and protected areas.

The wood supply decline issue has been of concern for some time, and the role of IFM in addressing this shortage has been explored previously. The past decade has seen increased use of IFM and intensive silviculture techniques. For example, the Forest Futures Fund was established to address the wood supply decline issue and to promote the use of intensive silviculture in Ontario. Ontario's Living Legacy has simply breathed new life into the subject of IFM.

During the past 3 years, the province of Ontario has undergone a comprehensive land-use planning exercise for its Crown, or publicly owned, lands. This process, known as Lands for Life, focused on 45% of the provincial land base. The far north, where we lack Timber Environmental Assessment (EAB 1994) approval to conduct forestry operations, was excluded. This process was the largest land-use planning process in the history of Ontario and probably Canada. The process took 18 months and consisted of 3 round tables and heavy public participation. As a result of the Ontario Living Legacy land use

strategy, protection has been extended to an additional 2.4 million ha as provincial parks, conservation areas, and forest reserves, representing 12% of the area of undertaking. This will cause further reductions in future wood supply. These impacts are currently being assessed, but best estimates indicate this may amount to an additional net loss of approximately 4 to 5% of the future wood supply. To mitigate the potential social and economic effects of this further reduction in wood supply, OMNR, forest industry, and the Partnership for Public Lands reached an agreement—the **1999 Ontario Forest Accord** (OMNR 1999b).

Commitments identified in the Accord were drafted on the basis of 2 fundamental premises (OMNR 1999b):

- Unless otherwise agreed to the satisfaction of the parties, there would be no net increase in the cost of wood delivered to the mill and there would be no long-term reduction in the supply of fibre necessary for processing on both a planning area and region basis, as a result of the establishment of new parks and protected areas; and
- The measures that are outlined within the Accord, if fully implemented, would contribute to addressing the requirements of the first premise.

The Accord makes specific provisions for IFM through several commitments:

5: Develop an Ontario forest science partnership to

- develop and test a range of IFM practices,
- assess the impacts of IFM on increased forest growth and yield,
- assess the environmental impacts of IFM, and
- direct science activities in support of Ontario's forest management planning requirements under the Timber Class Environmental Assessment and Crown Forest Sustainability Act.

#14: … designation of IFM areas (special supply areas) … limited to a mutually acceptable portion of the landscape.

#15: …obtain appropriate modifications to the Timber Class E.A. and the Crown Forest Sustainability Act … to permit IFM practices …

#16: The requirements of the Crown Forest Sustainability Act such as diversity will continue to apply to the extensively managed portions of the Sustainble Forestry Licenses (SFLs), but recognize that special provisions may be required for IFM areas.

#17: OMNR … will assign a higher priority to forest protection … necessary to protect IFM areas.

#22: There will be recognition of the costs, benefits, and impacts associated with IFM activities.

What are the foreseeable effects of the decline in future wood supply?

Future wood supply varies geographically. This is due to a non-uniform distribution of new protected areas and variable productivity across the area of undertaking. As a result, wood supply reductions vary across management units. Regionally, the wood supply issue is greater in the northeast than the northwest and also varies by tree species and forest product. Conifer supply is of more concern than hardwood supply since the province has a surplus of low quality tolerant hardwoods. Sawlogs are more of a concern than fibre for pulp and paper. In terms of products, white pine (Pinus strobus L.) and red pine (Pinus resinosa Ait.) sawlogs are the most critical wood supply issue.

The wood supply shortage is a mid-term challenge that is expected to occur within the next 20 to 40 years. As a consequence, IFM directed at this mid-term wood shortage must necessarily focus on stand intervention, as opposed to planting more trees. This supply shortage may or may not affect wood supply to the mill or decrease the viability of the forest industry. There is still time to implement IFM and for forest industry to adapt to future declines in wood supply.

What do we hope to achieve through this workshop?

A number of questions and myths about IFM need to be answered, addressed, or dispelled. The questions:

- What suite of IFM practices holds the greatest promise for Ontario?
- Are we doing all we can now, and if not, what are the costs associated with doing more IFM?
- Do forest managers have the science and information tools in place to do more IFM?
- How do we measure the positive and negative effects of IFM?
- What should be the basis for selecting areas for IFM on Crown land?
- What existing policies/guidelines need to be modified to promote IFM?
- What role should forest protection play in IFM?

- What jurisdictions in the world are leaders in IFM? Why are they leaders, can their successes be applied in Ontario, and can we learn from their mistakes?
- How do we ensure the support of Ontario's public, its politicians, industry, advocacy groups, etc. in promoting IFM?

Potential myths:

- IFM is a panacea to the wood supply issue!
- We have used IFM in the past!
- International experiences with IFM can/cannot be duplicated in Ontario's forests!

What, where, and why are the focus of this workshop—what about the who?

Who will benefit from or have an interest in the outcomes of this workshop:

- OMNR, with statutory authority for management of crown land
- Forest industry (SFLs in particular) will be beneficiaries of the results of IFM
- Proponents of parks and protected areas; the Accord identifies the possibility of future expansions after decreased wood supply is recouped
- Forest science community; i.e., OMNR, CFS, Forest Engineering Research Institute of Canada (FERIC), other research institutions, etc.
- Communities; i.e., forest dependent, aboriginal, that have grown to expect Crown forests to continue to provide a mix of economic, social, and environmental benefits the rest of Ontario's citizens have grown to rely on.

An Industry Perspective of IFM

Craig McManus
Senior Vice President, Forest Resources Division, Domtar Forest Resources, Inc.
(E-mail: craig.mcmanus@domtar.com)

Craig provided Domtar's perspective on Ontario's Living Legacy with respect to the progression from Lands for Life to Ontario's Living Legacy to IFM workshop. More simply, *where are we now, how did we get there, and how can we best build on our circumstances?*

Over the past 24 months, there has been a significant change in the climate of public opinion about forest industry. This may be summed up by a statement made by Tom Stephens, president of MacMillan-Bloedel, who pointed out that government licenses, approved plans, etc., mean absolutely nothing if the forest industry loses their social license to operate on public land. In Canada and Ontario, we are blessed and cursed with Crown land. Because forest industry is largely dependent upon Crown land for its raw materials, public land-use goals and objectives also influence their activities. As a result, social license and social acceptance is critical to forest industry in Canada. Public perception is eventually mirrored in public policy. Currently, the public has a poor impression of the forest industry because of issues associated with, for example, Algonquin and Temagami, Ontario, and Cloquot Sound, British Columbia. In Quebec, revision of legislation to transfer responsibility for forest management from government to industry was derailed by Richard Desjardin's film, *L'Erreur Boréal*.

An example of the effect of public perception on public policy occurred in the northwestern U.S.: from late 1980s to mid-1990s, 9 billion board feet (21.2 million m^3) of timber was removed from active harvest in California, Oregon, and Washington (roughly equal to 50% of Canada's annual lumber production).

Given past experience in North America, the Lands for Life process was well positioned for a win-win situation for government, industry, and environmental interests. The objectives of the process were to: (1) complete Ontario's system of Parks and Protected Areas, (2) recognize the land-use planning needs of resource-based tourism, (3) provide greater certainty for resource users, and (4) explore enhanced opportunities for outdoor recreation. In addition to these objectives, Premier Mike Harris personally committed a 12% target area to environmental interests. In October 1998, draft findings of 3 regional round tables recommended 64 new provincial parks, 157 new conservation areas, 89 new stewardship reserves, 92 enhanced management areas, 4 heritage waterways, and 2 heritage coast lines. Despite huge gains, this fell short of the Premier's commitment of 12%, with a provincial election imminent. In this case, parks were being used as a surrogate for environment.

Initially, the forest industry was enthusiastic and supportive of a land-use planning exercise, and had in fact requested such an effort for many years. However, when confronted with the proposed objectives and the light industrial focus, their enthusiasm changed to nervousness. Early in the negotiations,

several things became obvious. The environmental community was more politically adept than the forest industry, and the 12% commitment was not being met. The environmental community increased the pressure. At this point, it became clear to many in the industry that a more collaborative, less adversarial approach was needed to resolve this issue to the mutual satisfaction of all parties. This meant abandoning the traditional win-lose approach to negotiations, where there is a winner and a loser in each agreement. As a result, industry agreed to support the 12% target, if the following ground rules for further negotiations were accepted: (1) government was an equal, active participant in the process, not simply an observer and facilitator, (2) only moderate environmental groups (i.e., Federation of Ontario Naturalists, World Wildlife League, etc.) were involved, and (3) principles of no net loss in fibre quantity or quality, and no net increase in operating costs to the forest industry were maintained.

Upon acceptance of these ground rules, the 1999 Forest Accord was struck after 3 weeks of intense negotiations to address concerns of forest industry. This was a truly historic agreement of national and international interest for potential application elsewhere.

What was achieved as a result of this collaborative, partnership approach?

- Parks and protected areas increased from 10 to 12%; an agreement was reached by the 3 partners to deliver on the 31 commitments contained in the Forest Accord (OMNR 1999b)
- Peace in the woods and a new relationship among partners
- Opportunities to increase wood fibre supply as well as a mechanism to further increase parks and protected areas

Wins

For government, the wins included commitments of industry and Partnership for Public Lands; resolution of the parks and protected areas issue; Ontario clearly viewed as being a leader in this historic agreement; peace in the woods, no negative impacts on jobs or communities; increased funding for forest research and development; and support for internationally recognized forest certification.

For the environmental community, wins included the 12% area now being mapped and regulated; peace in the woods; a new relationship with forest industry; a mechanism to further expand parks and protected areas; industry cooperation to mitigate wood volume losses; a positive model for other jurisdictions, and establishment of the Ontario Living Legacy trust fund.

For forest industry, the wins were commitments from government and Partnership for Public Lands; no negative impacts on supply, quality, and costs of wood fibre; peace in the woods; a new relationship with certain environmental groups; support for future protected area expansion, but on a mutually acceptable basis; support for a wood supply mitigation strategy; Ontario Living Legacy trust fund; and government and environmental community support for forest certification.

Perhaps the greatest achievement of the Forest Accord was the establishment of the Ontario Forest Accord Advisory Board (FAAB), overseeing and ensuring the delivery of 31 commitments of 3 parties, made up of representatives from government, industry and the environmental community, and reporting directly to the Minister. Currently, the map of parks and protected areas is being developed while the industry awaits delivery of a mitigation strategy.

It is essential that the partners close the gap between pre- and post-Ontario Living Legacy allowable cut. In the short-term, this gap can be closed through guideline optimization, wood flow rationalization, increased use of more species, and smaller wood. In the long-term, the gap will be closed by the results of IFM. This is essential to the growth of the forest industry. Forest industry must grow to be healthy. Closing this gap will also contribute to the environmental community's desire for more protected areas. IFM can make this happen, with gains to be shared among partners. There is an opportunity for all parties to focus on a common goal — more wood from less land.

Craig urged workshop participants to recognize the new opportunities arising from the Forest Accord. These include new funding for forest research, increased interest and focus on IFM, shared commitment, new partnership among players who will stand together as research moves IFM yardsticks forward with acceptable, scientifically sound practices.

An Interest Group Perspective of IFM

Tim Gray
Executive Director, Wildlands League, Toronto, ON
(E-mail: wildland@web.net)

Tim presented a short background about the Wildlands League, their goals and objectives, and their views about IFM.

The Wildlands League was founded in 1968. They're a membership-based organization and a chapter of the Canadian Parks and Wilderness Society. In response to the Lands for Life process, they worked with Federation of Ontario Naturalists and World Wildlife Fund to create the Partnership for Public Lands due to common goals and common approaches to the land-use planning process.

The Wildlands League works with government in policy development, legislative reform (e.g., CFSA), and associated issues such as forest management plans, park management plans, and Timber Class EA. They also work with industry on forest certification through the Forest Stewardship Council, and have had increasing involvement in national and international areas of forest policy. They also work with the public in soliciting input on forestry issues, and providing advice to people in the field.

Principally, the objective of the Wildlands League is sustainable forests. Elements of this objective are to establish protected areas in the 65 different natural regions in Ontario, and ensure that the protected area system represents the diversity that occurs in these 65 regions (e.g., geological forms, wildlife habitat). These protected areas serve as benchmarks on the landscape, i.e., control areas for comparison with areas managed for timber. These areas also contain cultural, tourism, and economic values. Wildland league members think that industrial forests should be as similar as possible to protected areas in environmental quality (wildlife species, water quality, and cultural, ecological and social values).

Future growth of parks and protected areas require maintained or increased fibre production from a smaller land base. However, IFM may result in less harvest pressure on extensive management areas, shorter road networks, and less ecological impacts. This may result in industrial forests that are more "natural". IFM is also viewed as a way of achieving multiple objectives in extensive forest management areas, making protection of other forest values easier. But, there are a number of concerns about the intended extent of IFM and the practices to be used.

Stand-level practices that contribute to the goals of the Partnership for Public Lands include thinning, partial cutting, increased use of prescribed burning, better stocking and utilization, species conversion for restoration (e.g., conversion of low quality hardwood stands back to native conifer forests), increased use of private lands for forest management (in southern Ontario), selection logging, afforestation of marginal farm land (southcentral Ontario), and stand improvement.

At the landscape level, they would like IFM to be practiced on productive sites near production centres or mills, but away from waterways and important ecological areas, and restricted to a small percentage of landscape. Design of landscape layout for IFM areas is important, with attention given to catchment basin effects and negative effects on wildlife. Any IFM practices that move more forest land closer to its original, natural condition are beneficial.

IFM practices of concern at the stand level include stand-level drainage, fertilization, genetically modified organisms, some types of tree improvement, introduction of exotic species, and increased use of pesticides. At the landscape level, concerns include loss of public tenure, species conversion of natural mixedwood forests to monocultures, and weakening of the legal and regulatory framework for forest management.

We need to make fundamental decisions about what forest industry in Ontario will be selling in the future; is it wood products or are we truly going to be selling "sustainable forest management". How do we define sustainability? How are we going to measure it?

Canada is an exporter of wood products to the world. What goes on in global markets will increasingly dictate what we can sell and who we can sell it to. Evidence of changing global markets for forest products are paramount in recent announcements by Home Depot and IKEA of their preference to move to purchasing strategies that reinforce consumption of sustainably produced wood.

We need to recognize that there is a real risk in assuming IFM can increase growth of fibre forever. We often hear that the forest industry needs to grow to be sustainable. This growth model simply doesn't make sense when applied to the forest industry because there is only a finite ability of the land base to produce a resource. A 2% annual increase in volume growth is needed to sustain an average pulp mill. This notion (i.e., industrial creep) or current industrial growth models of forest industry cannot persist. At some point, Ontario needs to decide what mix of quality, quantity, and social services from our

forests we are marketing to the rest of the world. Secondly, we need to join with others to ensure that those who do not offer this mix of social, environmental, and economic services, will not have an opportunity to sell into this market. The growth model for industrial forests in the world is changing, and it has to change in Ontario as well. The Wildlands League wants to be a part of that.

Ontarions also need to recognize that wood supply decline is not simply a function of age class distribution, forest management planning guidelines, and land withdrawals for parks and protected areas. Rather, there is a finite level of harvest that can be achieved while allowing the other products and values of the forest to persist. The old model viewed protection of other forest values as a constraint to industrial growth and viability. These values need to be viewed as a part of the mix of products that are sold to the world. As an organization, Wildlands League is working with the Federation of Ontario Naturalists and the World Wildlife Fund and is committed to making this happen. That is why these organizations are involved in forest certification and the Forest Accord, and are interested in how IFM fits into the overall landscape. They are committed to assuring that forest industry and forests in Ontario are sustainable in the long term. This means finding social solutions to situations such as those that existed in Ontario prior to Lands for Life. This means change, and change is difficult. Although they agree that Ontario's Living Legacy should not result in loss of jobs or industrial viability, this does not mean these organizations have abandoned their fundamental commitment to sustainable forest harvesting.

The Forest Accord provides a model of how environmental interests, industry, and government can work together to designate protected areas, reform forest policy, and move forward together. We hope this model is exported outside Ontario's borders. The Forest Accord will help us to fit into the emerging and expanding global marketplace for forest products. It also gives us an opportunity to show we can work together to deliver on our commitments, expand protected areas, provide long-term security for forest industry, and achieve the goals that the public expects us to meet.

Practices Session

Current Forest Management Trends in Scandinavia

Mats Hagner
Swedish University of Agricultural Sciences, Umeå, Sweden. (E-mail: mats.hagner@ssko.slu.se)

Forest management practices were intensified in Sweden several decades ago to mitigate a projected wood-supply shortfall by 2010. To date, first-generation tree-improvement programs, the introduction of exotic species (principally *Pinus contorta*); and fertilization (75 kg nitrogen per ha every 5 years) have generated volume increases of 10, 30, and 100 to 200%, respectively. Additional 10% volume increases are expected from each of second- and third-generation seed orchards as they come on-line. After 25 years of implementing these intensive practices, the Swedes have found themselves with a wood surplus! To some extent, this surplus originated because they had underestimated the productivity of their natural forests, but to a larger extent, shortfalls were offset because of high wood prices and reduced industrial consumption. Intensive practices had produced a fast growing, young forest of low wood quality, and pulpwood is available abroad, at lower cost. They have come to the conclusion that, to stay in business, they must abandon the production of low-quality wood and focus on the production of high-valued wood products and customer-oriented marketing.

To increase wood quality, the Scandinavians are moving away from even-aged, clearcut silviculture to the management of uneven-aged, multi-storied forests. Their experience has shown that densely grown, uniform-sized trees mature at small diameter and net revenue per m^3 is low. Moreover, regeneration and tending costs in even-aged management tend to be high because of reliance on artificial regeneration and subsequent low volume recovery in thinnings. They have found that the age of conifers (pine and spruce) has a small effect on potential growth rates; small, old trees are very much able to respond to release. Also, the average genetic potential for growth is high in advanced growth and small trees. Consequently, they are encouraging the stratification of size classes in their stands. Scattered dominants grow fast (have high interest rates), mature at large diameters and, when selectively harvested, generate high net revenue per m^3. Selection cutting liberates crop trees with high potential value and fill planting is used to augment natural regeneration,

where necessary. Once there is sufficient quality in codominant and intermediate trees, the system is essentially thinning-from-above, and is known as "Liberich" —liberation thinning + enrichment planting. Volume production in the multi-storied forest is approximately equivalent to that in a single-storied forest, but wood quality is much higher.

In conclusion, Mats recommends that IFM be focused on the production of high value, solid wood products. He emphasizes that quality wood can pay for roads, bridges, and management, whereas pulpwood cannot. Economic efficiency is gained by the production of large, high-value trees and increased reliance on natural regeneration. Fertilization and genetic improvements can also be used within the context of multi-storied management to boost productivity.

A Forest-Level Perspective of IFM in New Brunswick

Bob Dick
New Brunswick Department of Natural Resources, Fredericton, NB. (E-mail: rcdick@gov.nb.ca)

The New Brunswick forest land base totals approximately 7 million (M) ha, of which about half is Crown land and the remainder is evenly divided between large and small private ownership. In 1974, a provincial forest resources study revealed a serious shortage in softwood fibre supply. The *Crown Lands and Forests Act* was written in 1980 and is still very much the driving force behind the current management planning process. This Act saw Crown land (3 M ha) divided among 10 licencees, each of whom are required to prepare forest management plans for their limits. Each plan forecasts timber and wildlife habitat supply for 80 years into the future, maps wood volume and habitat 25 years into the future, is updated every 5 years, and guides annual operating plans.

Since 1982, with the initiation of this management planning process, considerable refinement and improvement has taken place with each 5-year iteration. The initial forest inventory was very crude and has been considerably updated, becoming geographic information system (GIS)-based by the first 5-year update in 1987, and continuing to deliver more reliable estimates of wood supply and habitat over time. The second 5-year update in 1992 saw incorporation of the first *multiple use* objectives and, by 1997, biodiversity objectives and targets were in place. Currently, mature conifer habitat is managed for certain species of wildlife with 10% being reserved in specific spatial configurations. White-tailed deer (*Odocoileus virginianus* Zimmerman) wintering areas are identified and protected, although some harvesting and silviculture are prescribed to enhance these areas. All watercourses 0.5 m and wider are buffered by 30 to 150 m, but again, prescription harvesting is permitted to promote within-stand stability. Biodiversity is currently addressed through the maintenance of broad cover types, with standards being upgraded to identify and maintain certain vegetation community types at the ecoregion level by 2002. A protected-areas strategy is also being considered. Silviculture plays an important role in the achievement of non-timber objectives. Also important isthat the province funds all silviculture activity on Crown Lands, reserving the right to allocate future volumes.

A wood-supply model generates all forecasts of timber and habitat supply, based on inventory inputs, yield curves, and habitat definitions, and there are many checks and balances in the system. The inventory is updated annually for harvest and silviculture activity; cutovers are mapped and silvicultural inputs recorded. Post-cut surveys are conducted to determine developing stand type and condition and estimate future performance. Yield curve calibration is continually checked by comparing with actual scaled volumes. The lowest point on the wood-supply curve becomes the harvest level that is set by the Minister and these levels are monitored to ensure compliance. Habitat definitions place a "window" on yield curves to predict when stands enter and exit suitability for specific habitats. Recalculation of the annual allowable cut is made every 5 years, taking into account gains (i.e., measured silvicultural responses) and losses (e.g., from fire and insects).

New Brunswick has a substantial dependence on and investment in silviculture to meet wood-supply targets. For example, if silviculture had not been implemented in the past, the current annual softwood harvest would be about 1.5 M m^3 over an 80-year planning horizon. If all current silvicultural efforts were halted today and previous investments liquidated, about 2.5 M m^3 per year could be sustained. If the 1982-95 levels of silviculture are continued (7500 ha of planting and 9000 ha of spacing per year, at a cost of $8 M), 3.5 M m^3 would be available for the next 30 years and 4 M m^3 beyond 40 years. From 1995 on, an expanded silviculture program has been implemented (including an additional 1000 ha of planting and 16,000 ha of spacing, at a cost of $8 M), which will yield an expected future supply of 5 M m^3 beyond 40 years.

A Stand-Level Perspective of IFM in New Brunswick

Blake Brunsdon
J.D. Irving Limited, Saint John, NB.
(E-mail: brunsdon.blake@jdirving.com)

J.D. Irving (JDI) is a private, integrated forest products company that manages more than 2.5 M ha of private and public forest lands across New Brunswick, Nova Scotia, and Maine. The company is keenly interested in intensive and responsible management of these lands and has been planting trees for more than 40 years and precommercially thinning natural regeneration for about half this time. Given dramatic increases in the value of saw timber over the years, JDI's focus is on the production of high-quality solid wood products. Currently, their complete pulp mill capacity is met from sawmill residues.

JDI invests heavily in intensive silviculture. Site preparation, necessary for creating uniform and adequate planting microsites, currently costs between $50 and $350/ha, averaging about $150/ha. Nursery stock averages 12 cents/tree, or $300/ha, and costs an equivalent amount to plant. Releasing the crop from competition averages $125/ha, bringing total planted regeneration costs to approximately $875/ha. Tree planting has been very successful in the Maritimes, but where healthy advanced regeneration of an acceptable species is present, it makes good business sense to protect seedlings during harvest and promote their growth through precommercial thinning (PCT). PCT costs between $300 and $800/ha, averaging $650/ha. Commercial thinning (CT) is viewed by JDI as an important silvicultural strategy for promoting piece size and saw timber quality, and is conducted on both planted and PCT natural stands dominated by spruce. On planted sites, the first CT occurs between age 25 and 35, at a cost of about $1400/ha, with an average removal of 50 m^3/ha (or $800/ha revenue). While the cost of the first CT is seen as an investment in subsequent saw-timber production, the 2nd and 3rd thinnings that are conducted on better quality sites typically generate a profit because of larger piece sizes.

JDI views intensive silviculture as a sound financial investment. To illustrate the benefits derived from the silvicultural inputs described above, Blake illustrated the growth responses they are observing and forecasting on some of their high-quality sites. With adequate natural regeneration, and no subsequent silviculture, wood volumes of 200 m^3/ha are expected at age 60. PCT at age 10 to 15 provides the same yield, 20 years earlier. On equivalent sites, planting yields 300 m^3/ha by age 40. CT at age 25 and 35, yields 50 + 100 + 400 m^3/ha by age 60. More importantly, these intensive silviculture practices increase piece size and solid product value. At earlier ages, studies have shown that site preparation and herbicide release can give important early volume gains of 150 to 200%. Tree improvement efforts result in volume gains above those already mentioned. First generation, second generation, selection of best families, and cloning can result in additional volume increases of 15-20, 25-30, 40, and 50%, respectively. Based on today's timber values and yield expectations from these activities, JDI estimates an 8% return on investment, without considering related increases in product quality and uniformity, potentially worth as much as the yield benefits. Intensive silviculture is, therefore, a sound financial investment, offering excellent financial returns. Some of the practices that JDI has thus far not found to be economically viable include seeding, fertilization, and ditching.

In addition to economic returns, JDI feels that intensive silviculture also provides significant ecological benefits. Intensively managed stands develop quickly physiologically and structurally, providing "mature" habitat much sooner than unmanaged stands. At a young age, CT stands provide key habitat features that are required by many "old-growth" dependant species. PCT provides an opportunity to favour and promote under-represented species, such as cedar (*Thuja* spp.), white pine, black ash (*Fraxinus nigra* Marshall), and other important wildlife species and structures. The increased yields from intensive silviculture can also significantly offset constraints associated with the management of non-timber values on other areas. In conclusion, Blake stated JDI's view that IFM makes good economic and ecological sense.

IFM: A Weyerhaeuser Perspective

Tom Terry
Weyerhaeuser Co., Centrailia, WA.
(E-mail: tom.terry@weyerhaeuser.com)

Weyerhaeuser currently manages 1.36 M ha of forestlands in the southeastern U.S., 0.8 M ha in the northwest U.S., and about 13.8 M ha in Canada. Land management is a separate business entity from Weyerhaeuser's wood processing facilities and forest assets are managed as a profit centre, for long-term shareholder value. Like the organizations represented by our previous speakers, Weyerhaeuser's focus is on the production of high-value solid wood products, namely saw timber with specific characteristics.

Like J.D. Irving Limited, Weyerhaeuser practices IFM because they feel it makes good business sense. Although input costs are higher, intensive practices result in higher yields per unit area and larger piece sizes (higher value products) over shorter investment periods. To realize these benefits from IFM, several key prerequisites must be addressed at the corporate level, including a clear wood supply strategy, sound inventory, reliable quality-control process, and investment security.

A clear wood production strategy integrates market demands for forest products and objectives for non-timber values and identifies exactly what will be produced on specific portions of the landscape for maximum return to the landowner. The wood production strategy serves as a guide to silvicultural investments and regimes and provides direction for the forest research program. In essence, it provides a framework for the management and enhancement of timber and other forest values, including water quality and fish habitat, wildlife habitat, soil productivity, aesthetics, plant and animal species diversity, and culturally or historically unique areas.

The wood production strategy and the implementation of IFM imply the presence of an accurate forest inventory. To best meet current demands for both timber and non-timber products, we must know what we have, by species, soil type, landform, and climatic zone. To strategically meet future demands, we must understand what we *could* have under various management regimes. This dimension of the inventory implies the presence of a strategic silvicultural database that can be used to determine the implications of various silvicultural treatment options on tree growth and wood quality. Such a database should be constructed with silvicultural decision making in mind and, as such, be comprised of data collected to reflect critical variables, responses, sites, and times considered for operational implementation, as well as research data collected to document responses to a range of experimental treatments. Responses consist of conventional growth and yield data, and economics, as well as effects on non-timber values. Treatments should extend beyond "normal ranges" to sketch out extremes and minimize extrapolation uncertainty. Both internal and external research results can be drawn upon. Because of the long-term nature of the generation of silvicultural data, there is a need to look forward and anticipate potential future needs. Construction of the strategic database is a long-term endeavour that must be given high priority throughout good times and bad.

Quality control implies continuous feedback and monitoring, i.e., adaptive management. Silvicultural effectiveness monitoring and feedback are critical to the success of intensive practices. We must have a process in place whereby data from our operational monitoring and research efforts are continuously extracted from the strategic database to fuel decision making, guideline development, and training. The process is cyclic, with constant feedback being used to fine-tune practices.

Finally, Tom stressed that ownership is requisite to investment in intensive silviculture. The investor must maintain an economic equity interest in the crop and returns and risks must be acceptable. This is something that has yet to be addressed here in Canada and it implies a long-term commitment to forest protection.

IFM: A Westvaco Perspective

Phil Dougherty
Westvaco, Summerville, SC.
(E-mail: pmdough@westvaco.com)

The southeast is one of the major pulp and solid wood producing regions in the U.S. Although Westvaco is a relatively small player in this large region, it is unique in its long-term commitment to forest research. More than 4 decades ago, Westvaco initiated an applied silviculture research program which, over time, has addressed tree improvement, fertilization, weed control, and, now, biotechnology, and genetic manipulation. Phil emphasized the benefits of IFM, commitments required for its implementation, productivity gains, and future research areas.

The forest industry in North America must increase productivity to compete in a global market with countries that have highly productive lands and low labour costs. Increasingly, entering these global markets also requires that we demonstrate ecologically sustainable forest management. Intensive silviculture has played an important role in meeting these criteria, by allowing increased productivity on fewer hectares. As identified by previous speakers, intensive practices can increase our competitive capacity by reducing the cost per unit of timber produced. Moreover, focussing efforts on strategically located productive land reduces costs for taxes, administration, and road infrastructure, and frees up portions of the land base for other purposes. Currently, IFM in the southeast has allowed mill requirements to be met despite setting aside more than 30% of the land base for diversity corridors, streamside management zones, and other special management areas. IFM has an important role, therefore, in offsetting losses in timber production capacity due to

forestland reductions from urban encroachment and setbacks for important ecological functions other than timber production.

Successful IFM requires a solid commitment to forest research. Strategic databases and silvicultural effectiveness monitoring, as Tom Terry mentioned, are essential to the adaptive management process and the evolution and refinement of practices. In addition, there must be a commitment of capital to discover, develop, and implement new technology. There must also be a commitment to demonstrate and ensure that our practices are sustainable and ecologically sound. Much more effort is required to demonstrate the maintenance of soil productivity.

At Westvaco, silviculture and research have paid large dividends. By the late 1950s, many stands had been high-graded several times (what Phil refers to as "reverse genetic selection") and productivity was low. Through the implementation of stocking control, drainage, bedding, release, tree improvement, and phosphorous fertilization, productivity was doubled on these areas (to 12 m^3/ha/year) through the course of a single 20-year rotation. Between 1970 and 1990, research efforts focused on high production logging, family selection, herbaceous weed control, and mid-rotation fertilization, and productivity was again doubled (to 24 m^3/ha/year). Recently, efforts have been directed at soil productivity mapping and site-specific prescriptions, low-impact logging and harvest scheduling, mass control pollination, hardwood plantations, and clonal forestry. Future research areas include entire rotation nutrient management and genetically engineered trees, with yields expected to reach 48 m^3/ha/year by 2010!

In concluding, Phil advised us not to be too constrained in our thinking about what technology can do; what different species, climates, and soils are capable of. In discarding unsuccessful treatments, we need to be sure we know what the limiting factors are on our sites. Also, we should not be too quick to dismiss practices such as fertilization, genetic improvement, etc., for these may be the very technologies that, applied correctly, allow us to maximize the availability of other forest values. Finally, Phil emphasized *don't be afraid to reinvent the wheel; the road we're driving on, the environment we're passing through, often changes and sometimes we need a new wheel!*

Menominee Sustainable Forestry

Marshall Pecore
Menominee Tribal Enterprises, Neopit,WI.
(Phone: 715-799-3896)

The Menominee people have inhabited northeastern Wisconsin and part of Michigan's Upper Peninsula for more than 10,000 years. Originally spanning more than 4 M ha, their tribal lands have been reduced to a mere 95,000 ha by cessions and treaties dating back to 1854. Over 93% forested and managed intensively for more than 140 years, the Menominee Reservation is unique and has been described "as an island of timber in an ocean of cleared land". The entire forest is managed under sustained-yield principles, with the goal of producing maximum quantity and quality of saw timber, while maintaining the diversity of native flora and fauna. Importantly, sustainable management of the Menominee Forest translates to "sustainable community", and the long-term health and well being of the Menominee people; Marshall referred to this as the "human element" that drives why their forests are being managed.

Menominee's charge to manage the forest for future generations motivates the implementation of management practices that will ensure biological integrity. While markets and consumer preferences change, only those species and volumes are harvested that have been derived from sustainable silvicultural systems based on developing quality saw timber. In Marshall's words, *the forest drives the sawmill; the sawmill doesn't drive the forest*. Occasionally, this results in the need to market species that are not in peak demand, with reduced short-term profit; however, it is believed that this practice will ensure the greatest long-term economic stability.

The Menominee's management is based on the vigour characteristics of a tree or stand, and often results in longer rotation lengths and larger trees. Trees are only harvested when they approach biological maturity and are about to lose significant grade or scale before the next entry. The resulting longer rotations produce higher value veneer and sawlogs and "quality always sells". This practice also allows ecosystems time to "mature". Occasionally volume is lost in the older age classes, but this is seen as an "investment" in the ecosystem, producing coarse woody debris, wildlife snags, etc.

The Menominee people have maintained the same basic management philosophy for more than 140 years. Their success is evidenced by the fact that standing saw timber volume has increased from 2.8 million m^3 in 1854, to 4 million

m^3 today, despite the harvest of 5.3 million m^3 over this period! Their silvicultural practices and prescriptions are highly site-specific. Species are chosen by the capacity of the site to produce the highest quality and value possible. Silvicultural systems are chosen to best promote the target species on the given site; the full range of systems are used. Approximately half the forest is managed using uneven-aged systems. Single tree and group selection are implemented to promote tolerant hardwoods on about 2600 ha per year. The other half of the forest contains target species that require disturbance to maintain their presence. Shelterwood prescriptions are implemented for white pine, red oak (*Quercus rubra* L.), hemlock (*Tsuga canadensis* L. Carrière), and yellow birch (*Betula alleghaniensis* Britton) on about 280 ha per year. Clearcuts are used to regenerate aspen (*Populus tremuloides* Michx.) or convert aspen to more desirable species on about 130 ha per year. Tree planting, pruning, and release are conducted on over 800 ha per year. Logging is closely monitored to ensure integrity of the silvicultural prescription and minimize damage to crop trees and site. Marshall indicated that there is a serious need for the development of small, low-impact machinery for this type of forestry.

While Menominee has received much recognition, Marshall admits that they are still learning and, like the speakers before him, stressed the importance of long-term effectiveness monitoring and adaptive management. Perhaps his strongest advice lies in the development of a sense of forest conscience; the desire to feel the accomplishment that will come when our grandchildren pause and say that their elders did things right.

Applications Session

Virtual Tools for Effective Forest Operations Planning and Cut-to-Length Harvester Operator Training

Tim White and Paul Holman
Timberjack Inc., Woodstock, Ontario
(E-mail: tim.white@ca.timberjack.com)

As economic, social, and environmental pressures place more constraints on our productive land base, forest managers are increasingly faced with meeting their fibre needs through smaller wood derived from practices such as thinning and selection cutting. Moreover, mills are demanding fresh, clean wood, forcing loggers to walk a tight rope between hot-logging throughout extended seasons and protecting the environment. Today's cut-to-length (CTL) harvesting machines were designed for just such an environment.

CTL harvesters represent state-of-the-art technology that require many special skills from operators. More than ever, the operator plays a critical role in logging, both in the long-term effects of harvesting on the forest and the operation's economic success or failure. CTL harvesters require operators with excellent mechanical skills, good hand-eye coordination, and a basic understanding of computers. In addition, knowledge of forestry practices is essential because operators play a greater role in planning harvesting operations. Not surprisingly, it takes both knowledge and practice to acquire the skills to develop the right touch for the job, making training essential.

Tim stressed repeatedly that *training is expensive; good training is very expensive; no training is the most expensive.* On-the-ground training is possible, but the 1 seat belt –1 person in the cab rule requires trainers to stand at least 2 tree lengths away from operating equipment and use remote communications for instruction. Through simulator training, many potential operators can be trained simultaneously by a certified instructor before they start working with a real machine. This provides a safe training environment and avoids damage to both the forest and the machine. Operators can also learn effective harvesting strategies, such as cut-block layout, directional tree felling, and product sorting, all while driving through a virtual forest.

In response to training needs, Plustech Oy, a Timberjack-affiliate company specializing in advanced long-range product development, has developed a simulator that creates realistic working conditions for both landscape and machine operating levels. The unit comprises a harvester simulator and a Forest Landscape Simulator (FORSI).

The harvester simulator is a state-of-the-art tool that includes basic to advanced skill levels and is modelled after an actual machine. Instructors can select harvesting conditions, terrain, strip roads to travel, and trees to be removed. The entire training environment is designed to mimic actual CTL harvesting conditions through sound effects and visual animation. Trainees sit in a virtual cab and drive the harvester through a virtual stand while harvesting marked trees. The simulator records travel time, use of machine components, and number and dimensions of trees harvested. Results are measured in terms of costs, quality, and volume harvested. Repeating the same situation at different machine settings permits trainees to evaluate their

strengths and weaknesses, encourages self-learning, and enables objective comparisons among trainees. The simulator's modular structure makes it possible to upgrade it in response to machine evolution.

FORSI is a software package that automatically creates a 3-dimensional virtual landscape by applying digital map information and forestry databases. An efficient tool for planning logging operations and creating virtual images of the impact of harvesting on the forest landscape, FORSI can be used to create virtual visual landscapes of a desired forest area. If the user's GIS system includes growth models, the landscape can even be visualized over time, to show the long-term effects of various treatments. FORSI can also be used to compare effects of alternative harvesting operations. In this way, landscape effects can be determined before harvesting occurs.

Changes to a forest environment resulting from timber harvesting are long lasting, therefore the effects of logging operations should be carefully weighed and planned beforehand. Tim and Paul stress that we cannot succeed with IFM unless we are satisfied that our equipment operators can deliver on our plans in the woods.

Implementing IFM in the Woods

Philippe Meek
Forest Engineering Research Institute of Canada (FERIC), Montreal, QC
(E-mail: pmeek@feric.ca)

For much of Ontario's forestry sector, IFM will represent a major shift from traditional forestry. Foresters will be challenged from 2 sides; they must promote an environmentally acceptable way of managing the forest, while sustaining or increasing the value of forest products for the benefit of their partners. This will mean an increased use of silvicultural tools to improve stand conditions, thereby providing an appropriate growth rate and favouring rapid and efficient stand renewal. The acceptability of these approaches will be demonstrated when the maximum possible forest area shows evidence of proper management. With this in mind, FERIC is developing tools that will help foresters achieve their silvicultural objectives. Tending treatments for juvenile stands, intermediate partial cuts such as commercial thinning, and shelterwood regeneration systems are all considered priorities. Although FERIC has many other related priorities, Philippe focused his presentation on these 3 areas. These treatments were developed as part of the toolbox for even-aged management, but are equally attractive for mixedwood forests.

Treatments for juvenile stands

Research and development efforts for precommercial thinning are focusing on cost reductions for most stand conditions. Because motor-manual tools are appropriate, but expensive, FERIC is looking at mechanization to widen the range of treatable stands at a more reasonable cost. In terms of cost, combining manual and mechanized tools appears to be a promising option for treating tall stands, cleaning suppressed regeneration, controlling stand composition, and so on. However, problems arise in terms of the quality of these precommercial treatments. Guidelines generally aim towards the high quality of a manual operation, but machines capable of meeting these requirements are not yet available. Significant cost reductions are possible if less restrictive guidelines are considered, but optimal situations, with acceptable cost and quality, have yet to be defined. The objective is to propose ways to treat all stands available for wood production. For example, a jack pine stand with 44,000 stems/ha can be manually treated for $870/ha but the cost drops to $514/ha when mechanical and manual methods are combined.

Intermediate partial cuts such as commercial thinning

European forestry has demonstrated for many years that commercial thinning helps to control and promote the growth of higher-value trees. However, silvicultural scenarios with intermediate cutting that would fit most stands and sites have not yet been defined; optimal solutions would consider both economics and growth response. Experience in commercial thinning of natural boreal forests and plantations is increasing rapidly, and the costs of current operations are known. The opportunities for thinning in natural stands before maturity are numerous, and many variations of the treatment are used in the Canadian boreal forest. Specialized equipment or currently available machines can be used to achieve such goals. Early thinning, where trees are smaller, costs $20-30/m^3; late or shelterwood thinning costs $15-20/m^3.

Shelterwood regeneration systems

Finally, regeneration objectives can be achieved by implementing shelterwood approaches in mature stands. This would help mitigate the high cost of the regenerating clearcuts using site preparation, planting, and cleaning, and would help improve the acceptability of even-aged management. Three specific evaluations of components of shelterwoods were done by FERIC in collaboration with companies working in the boreal and mixedwood forests. Full-tree costs less than cut-to-

length systems. Tools exist to supplement the traditional clearcut/site prep/plant/herbicide approach, but techniques that provide adequate light for shade-tolerant species and create adequate seedbeed conditions for regeneration still need to be developed.

The toolbox is being developed. It's up to the practitioners to start using more of the options to their advantage.

Stand-Level Tools to Guide Our IFM Decisions: A View From the Trenches

Bill Towill and David Archibald
Ontario Ministry of Natural Resources, Northwest Science and Technology and Bowater Inc., Thunder Bay, ON
(E-mail: bill.towill@mnr.gov.on.ca; archibaldd@bowater.com)

Bill and Dave spoke of the importance of taking a retrospective view of the tools already available for support and guidance in decision making. They defined decision making and outlined several tools available for decisions related to prime site selection, development of silvicultural strategies, and forest management planning.

A *decision* is a choice, in the face of uncertainty, among 2 or more options. There are a number of important factors in decision making with respect to forest management. The skills and knowledge of practitioners in choosing appropriate tools; the skills and knowledge to use the chosen tools appropriately; and, since no 2 places in the forest are the same, appropriate flexibility when using the chosen tools. In addition, since many voices have input into how the forest is managed, decision tools are not necessarily entirely based on science.

Decision tools help reduce complexity and organize large amounts of data to make forecasts and predictions to help us make decisions given a series of choices. Decision tools can help to build core competency in new staff through adaptive reasoning and guiding them through a series of possible choices and consequences. However, tools can also be misused. Inputting poor data and/or improper assumptions will result in poor forecasts. We need to know the potential errors in forecasts and understand the pitfalls associated with relying too heavily on decision tools. In the end, it's not machines or tools that make decisions, it's people.

Current challenges to resource managers include sustaining or increasing wood supply by managing the remaining *old* forest; managing for quantity and improved wood quality and increased value in the *new* forest; managing to reduce time to operability; and managing to reduce future access, harvest, and transportation costs to increase the economic wood supply.

The key drivers of forest harvest levels or the annual allowable cut are growing stock, growth models, and the suite of silvicultural options applied on a given site. The principles of strategic silviculture are:

- What, when, where, and how much silviculture influences wood supply, quality, and values for many decades
- Silviculture programs must be custom-designed for the forest age-class structure
- Silviculture is also a business…which means doing the right things for the right reasons at the best cost.

Intensive forest management and intensive silviculture (IS) are often used interchangeably, but they shouldn't be. IFM is the implementation of a suite of biologically effective and economically efficient forest management activities that contribute to a broad array of forest-level objectives. IS refers to specific treatments used to increase timber volume or value above the normal timber yield, reduce time to minimum operability, and increase average piece size.

Prime land refers to inherent productivity and is a mapable entity. *Prime site* refers to prime land coupled with economic efficiency and opportunity; i.e., roads and mill locations influence areas defined as prime sites, making these moving targets.

Some of the options for managing natural stands include increasing fibre recovery through technological improvements in harvesting and processing, using modified silvicultural systems to capture potential mortality and secure regeneration, and improving the allocation of remaining old forest based on how long it can be stored on the stump.

There are a range of silvicultural strategies; i.e., match species to site, plant fast-growing conifers or genetically improved stock, regenerate the site as fast as possible, maximize the use of available growing space, practice density regulation, and maintain non-crop vegetation below critical values. The main thing is to be "consistently good, consistently".

Economic analyses are necessary to determine a net productivity value for Crown land; i.e, the level of silviculture needed to meet return on investment needs. This comes back to setting objectives, which can include increasing volume, wood quality, and so on.

Where are we with silviculture and science in Ontario? We know a fair bit about site preparation, stock production, vegetation management, and tree improvement. However, science gaps exist in the areas of precommerical and commercial thinning, silvicultural treatment effects, and mixedwood management.

There are many tools available; for example, tools that help to reduce ecological complexity: prime land and site designations for 2 regions, site-specific ecologically based silvicultural guides, seed zone maps, forest health and disease surveys, and benchmark yield curves. There are also tools for organizing data and information; for example, ecosite-based silviculture guides, record-keeping systems, Ontario's sustainable forest management model (SFMM), and TCM/PAM (a timber survey tool). There are tools for converting data into forecasted outcomes, for example, ingress of naturals information, stand density management diagrams for 3 of our 6 major crop species, stand-level growth and yield models, and tools to enable adaptive learning, including tree marking guides, ecological land classification/forest ecosystem classification (ELC/FEC) systems, and critical silvics guides.

We have a lot of tools; however, in some cases they need to be refined, in others the information needs to be transferred to resource managers. The future requires a balanced approach to discovery, development, transfer, and implementation and monitoring. Bill and Dave stressed that we need harvest-to-harvest sequences for our forest types. This type of crop planning would help us to document our assumptions and resulting products. We also have many old trials…lost knowledge means missed opportunities and costs in terms of time, money, and efficiency. These need to be followed up on. To move forward from where we are now, we need increased synergy and cooperation among science specialists and practitioners.

A Landscape-Level Perspective of IFM Potential in Ontario

David Baldwin and Ajith Perera
Ontario Ministry of Natural Resources, Ontario Forest Research Institute, Sault Ste. Marie, ON
(E-mail: david.baldwin@mnr.gov.on.ca; ajith.perera@mnr.gov.on.ca)

Dave focussed on the broad issues associated with IFM in terms of how areas would be selected, and what areas are accessible. He discussed the options, then looked at the spatial feasibility of these options, the knowledge requirements behind landscape-level questions, and how IFM will relate to existing land-use policies.

IFM should result in less nomadic forestry; i.e., we will have a longer and more intense temporal commitment to the same space. Therefore, area selection is critical. The actual layout of IFM areas on the landscape will be a function of 3 very broad categories: societal values, economics, and ecology. In looking at the spatial feasibility of IFM, the social filter, or which societal values are driving or limiting what can be done on the landscape, the ecological potential of the areas we can actually select, and the economic feasibility of IFM on those same areas, are all important considerations.

Lands for Life and the Living Legacy documents provide a macro socio-ecological filter, and we are left to decide what of the remaining area can be used for IFM. The most obvious things to look at are the productivity and natural disturbance regimes of those areas. Terrain, slope, existing road networks, and mill location all affect accessibility and economics.

The information required to select IFM areas includes:

- Land cover – currently we have land cover from satellite imagery for the entire province, coupled with forest resource inventory data (FRI), which provides coverage for most of the area of interest.
- Climate – we have climate data as it relates to seed zones, and species ranges.
- Terrain – we have a complete 1-km elevation model, and partial coverage at a finer resolution of 100 m.
- Substrate – including bedrock geology, which provides the broader ecological context for describing areas, is available at broad scales. Surficial geology or soils information, especially at the landscape level, is badly needed. A federal data set exists that provides very general

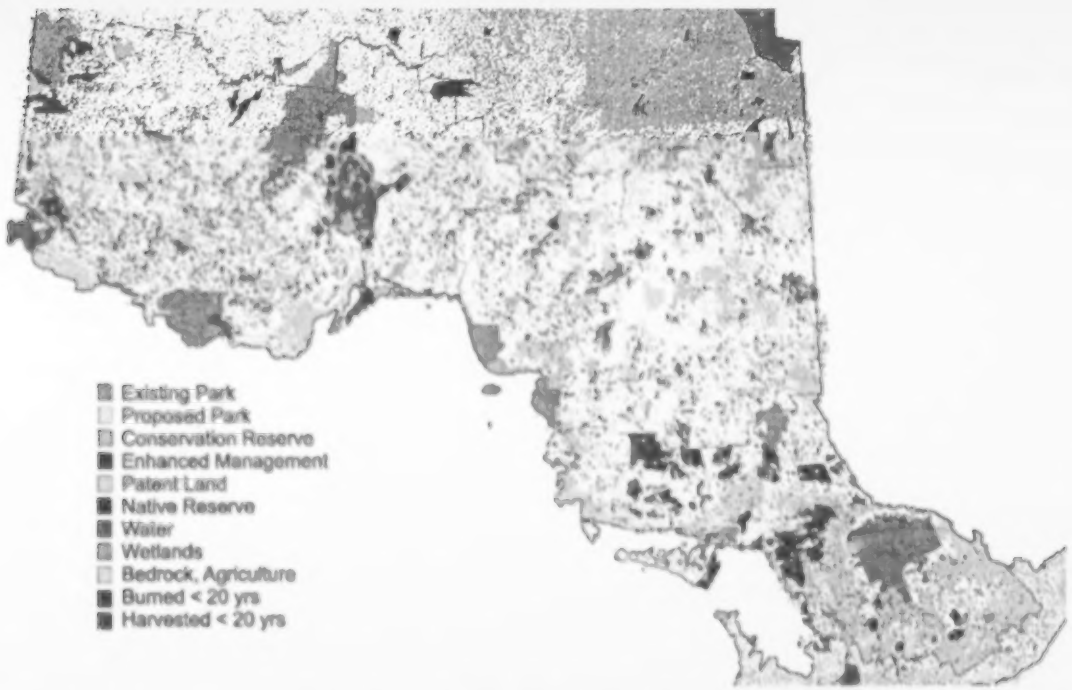

Figure 1. Area left to consider for IFM after removing water, rock, parks and protected areas, private lands — essentially all the other uses.

information about texture and moisture over very broad areas. Finer data is available in the provincial data set, but coverage is incomplete.

- Road network – most major roads are visible on the NTS provincial series maps. However there isn't an overview of logging access roads.
- Past disturbances – knowledge of burned and harvested areas and their adjacency to past disturbances will be important in terms of emulating natural disturbance regimes and planning protection programs.
- Additional information – including landscape productivity, wildlife habitat supply, vulnerability to disturbance, and susceptibility to pests and diseases.

Finally, there's the spatial feasibility of IFM. Removing the land allocated to existing parks, the additional areas from the Lands for Life exercise and proposed parks, conservation reserves, and enhanced management areas from Ontario's Living Legacy, the remaining landscape is limited. Withdrawing patent land, private land, and native reserves, especially in the south, very little Crown land remains. Removing water, particularly in northwestern Ontario, the landscape decreases again. Removing wetlands and clear bedrock, agriculture, and barren land, limits available area even further. Considering areas that have been disturbed in the last 20 years, and adjacency to those areas, we've narrowed down the land base to what's left to potentially allocate for IFM (Figure 1).

Planning for Forest Protection: The Spruce Budworm Decision-support Model

David MacLean
Faculty of Forestry, UNB, Fredricton, NB
(E-mail: macleand@unb.ca)

Using spruce budworm (*Choristoneura fumiferana* Clem.) as an example, David discussed the interactions among yield prediction, harvest scheduling, and forest protection. Fire, insects, and disease result in direct yield losses and associated indirect harvest scheduling impacts. Yields and optimal scheduling can be maintained by protection or, if protection is not possible, losses can be reduced by proper harvest planning.

Increased investment in silviculture is assumed to increase sustainable harvest levels. If a pest, such as the spruce budworm, is affecting stand yield, it affects all aspects of allowable cut determination. Spruce budworm eats current foliage of balsam fir (*Abies balsamea* (L.) Mill.) and spruce species, resulting in growth reductions, and ultimately mortality, depending upon factors such as stand age and site quality. Thinned trees are more vigorous and are better able to withstand and recover from budworm defoliation. However, additional treatments may be required at the peak of an outbreak to maintain growth rates at a level required to maintain or increase harvest levels.

Over the last 20 years, we have increased our ability to predict and model growth and mortality effects. Stand growth models have been developed that use defoliation as inputs to predict stand-level growth and mortality response as an output. When used in decision-support systems (DSS), these models enable us to build the effects of budworm into forest management planning.

DSS are often used in operational planning to predict the timber supply benefits of protection and for harvest scheduling. In simple terms, the user digitizes proposed treatment blocks into the system to estimate the potential cubic metre per ha benefit.

DSS can be used to project effects of budworm outbreaks and management on forests in a scenario-planning context and assess the degree of uncertainty and the impacts on allowable cut associated with whether a budworm outbreak happens or not or whether protection is provided or not. DSS can also be used to optimize insecticide use in terms of where and when they can be applied for maximum benefit. It is possible to take defoliation survey information and identify stands that are budworm susceptible, simulate different protection/outbreak scenarios (e.g., normal budworm outbreak versus severe outbreak) and provide justification to politicians and the public for taking corrective action.

DSS also provide a value-added conversion of raw inventory and monitoring data. They quantify the benefits of alternative strategies and identify priority areas. So if protection activities are going to be used, they help us to focus these activities on areas that provide the best economic return. DSS can also predict the successional response of not protecting stands.

Social, Environmental, and Economics Session

Public Opinion and the Environment 1999 – Wave III

Chris Coulter
Environics International, Toronto, ON
(Email: chris_coulter@environics.ca)

Chris emphasized that although polls are not necessarily a good indicator of future trends, they demonstrate which issues are top-of-mind with the public, and indicate concern and awareness. Research indicates that we, as a society, are on the verge of a third green wave of public environmental awareness. The first green wave was in the 1960s, led by Rachel Carson's publication of *Silent Spring* and the Apollo photograph of *spaceship earth*. The second green wave was from the late 1980s to the early 1990s. The number of people indicating environment as the most important issue facing Canadians jumped from a few percent to over 20% in a few months, and stayed there for 4 years. Key issues and drivers of this third wave are:

- Health – concerns about personal health, especially by the baby boom generation
- Legacy – the need to leave something positive for future generations
- Nature – strong emotional attachment to nature and the natural environment

The environment is always seen as an important issue, but not always an urgent one. It is a core Canadian value, with over 80% of Canadians asked being concerned about the environment, mostly at a global scale. This is in contrast to individuals from developing countries, who tend to be

primarily concerned with the local environment. Some environmental issues are both important and urgent, with air and water quality and the preservation of nature being of primary concern. The stages in a society's greening are:

- Basic awareness – seeking sensation or entertainment
- Paying attention – seeking information
- Coming to judgement – seeking progress

Canadians increasingly seek information from multiple sources as their confidence in any single information source declines. Awareness of genetically modified organisms (GMO) is growing rapidly, with some uses (e.g., better drugs) acceptable, and some (e.g., increasing animal productivity) not. People no longer accept the trade-off between economic growth and protecting the environment.

People are making a connection between their health and environmental pollution. They are most concerned with issues over which they have no control. Because individuals feel they have little ability to make an impact, governments are increasingly seen as the ones to lead us to meeting environmental goals, but the public believes that government performance is declining. Nature is seen as important to our survival, and carries important emotional and spiritual values. Baby boomers tend to be most concerned with leaving a legacy of protecting the environment. Generation Y, the children of the baby boomers, were inundated at an early age with environmental values. Generation Xers, who grew up during a period of many scandals, are cynical. In general, people blame government for problems with the environment. This has serious implications for natural resource managers. The public feels the limits of individual action, and is now looking for institutional leadership, especially on big-picture issues.

Chris made reference to several resource management issues. There is a rural-urban split in public views of the best use of the forests, with ecotourism highly favoured by urbanites. Most people think that forest cover is declining, with industry, followed by governments, as being responsible. Clearcutting is the main forestry environmental concern, followed by pesticide use, overharvesting, and planting. The public has high expectations of large companies, and punishes or rewards companies based on perceptions. There is a need for resource managers to demonstrate action on ecosystem issues and the effectiveness of non-regulatory approaches before the window of opportunity closes. Chris stressed that leadership on environmental issues is critical.

Aboriginal Participation in Forest Management

Peggy Smith
National Aboriginal Forestry Association, Ottawa, ON
(E-mail: peggy.smith@utoronto.ca)

Peggy provided an overview of the many obligations and commitments that the government of Ontario has to Aboriginal Peoples. Condition 77 of the Terms and Conditions set out in 1994 in the Class Environmental Assessment Board's decision requires that the OMNR ensure a fair share of benefits from any forest economic development go to Aboriginals. There are Forest Management Planning requirements to conduct Native Values mapping or separate Native consultations if requested by Aboriginal communities. Ontario has also made a commitment in the Canadian Council of Forest Ministers Criteria and Indicators of Sustainable Forest Management to recognize and protect Aboriginal rights and Aboriginal participation as essential elements of sustainable forest management. These same commitments were made under Canada's National Forest Strategy. Aboriginal issues, including the conflicts between traditional gathering activities like berry picking or trapping and other uses, have been identified in the national Science and Technology research agenda as important. All of these obligations and commitments will influence how IFM is conducted in Ontario. Aboriginal communities and businesses must be involved in decisions about IFM and have access to training and contracts to carry out the labour intensive work that will be required.

Many people do not want to dwell on history. Some will argue that what is in the past cannot be changed, that we should get on with life, that we are all equals today and there should be no special treatment for any one group. But to forget our past only dooms us to repeat our mistakes. The Ojibway of northwestern Ontario, for example, lost many of their rights to resources, and opportunities for economic development through a treaty made with, and negotiated on their behalf by, representatives of the Crown. Many parts of their treaty have not been honoured. Since 1873, the relationship between the province and Aboriginal peoples has worsened. Resources have become scarcer, promises to uphold treaties have been broken, and commitments to address the inequities experienced by Aboriginal people have been forgotten. Attempts to negotiate government-to-government agreements with treaty organizations have been abandoned. Royal Commission recommendations to change the nature of the relationship with Aboriginal Peoples, have been ignored.

The relationship between the province and Aboriginal peoples—the Cree and Ojibway Nations has suffered because of the Lands for Life process. Lands for Life is described as a model of cooperation, a win-win situation. Unfortunately, the province elevated the forest industry and environmental groups to equals at the negotiating table and left out Aboriginal Peoples. The 3 winning groups (provincial government, forest industry, and Partnership for Public Lands) negotiated a package that increased protected areas and ensured no reduction in wood supply to the existing companies. Aboriginal rights, increasingly being recognized as prior and unique rights by the Courts, were ignored. Peggy claims aboriginal organizations were not invited to the table, but that the decisions profoundly affect their ability to exercise treaty rights such as hunting, fishing, gathering, and trapping, and limit their ability to share in economic benefits because there is no unallocated wood left in Ontario. This is not a win-win situation.

There is a foundation for a new relationship with Aboriginal Peoples in the form of treaties, and government-to-government agreements that recognize the unique place of Aboriginal Peoples in Canada. A negotiated solution, on a government-to-government basis, to define a new relationship with Aboriginal treaty organizations is possible.

Marshall Pecore spoke of a "commitment to place" as a foundation for the phenomenal forest management of their Menominee tribal lands. The situation is different in Canada. The total area of all of the Indian Reserves in Canada is less than the Navaho reservation in the United States. A different kind of solution was negotiated in treaties in Canada, the spirit and intent on the part of Aboriginal Peoples being to **share** the land and resources. The Indian Reserves in Ontario are, on the whole, too small to provide sustainable economies for Aboriginal communities. The only solution is to fulfill the spirit and intent of the treaties to share land and resources. The commitment to this place called Ontario must also demonstrate a commitment to the people, including a commitment to the original peoples of the Boreal and Great Lakes-St. Lawrence forests. The Living Legacy must include a shared commitment to, responsibility for, and benefits from our natural resources.

IFM and the Opportunity for Wildlife Conservation to Benefit under Ontario's Living Legacy

David Neave
Wildlife Habitat Canada, Ottawa, ON
(E-mail: dneave@whc.org)

Wildlife Habitat Canada (WHC) is a non-government organization that promotes linkages between timber and wildlife habitat objectives. WHC works with industry, governments, and environmental partners to create programs, such as the Forest Stewardship Recognition Program and the Forest Biodiversity Program. WHC assesses policies and issues to ensure that habitat is recognized in resource planning. They strongly support the National Forest Strategy and the CSA certification approach to sustainable forest management, and publish their own habitat status reports. WHC also funds conservation programs, and has provided nearly $30 million during their 15-year history under partnership arrangements for stewardship projects on Crown and private lands.

David Neave, Executive Director of WHC and co-author of a proposal for the management of natural forest landscapes, supports the use of landscape approaches to timber management for habitat conservation. He does not support carving the forest into single-use zones. He supports parks, but notes that they are not often designed for, or effective in, protecting wildlife and habitat. Biodiversity and wildlife habitats are a fundamental part of sustainable forest management and a key product of IFM. Wildlife can only survive through a landscape-level approach to managing our forests – not as artifacts for future generations to visit in living museums.

Wildlife and their habitat were clearly not a priority in the Lands for Life or Ontario's Living Legacy planning processes. Committing to no net loss of wood supply will mean more harvesting outside protected areas. Habitat guidelines are being reviewed with the expectation of allowing greater timber harvests. The $7 million portion of the trust fund primarily allocated for fish and wildlife programs, will at best only help to minimize the effects of future land use and resource management decisions. This view is shared by the majority of the Ontario Provincial Forest Technical Committee.

WHC wants to be a partner in IFM programs that protect wildlife habitat in the landscape, and that integrate habitat protection into forest management plans. For example, Weyerhaeuser uses landscape-level planning to achieve biodiversity while meeting silvilcultural objectives. Incorporating habitat objectives into forest management planning is also a realistic goal for crown

lands. Sixty to 80% of the management plans on private lands under OMNR's managed forest tax incentive program have wildlife habitat conservation and environmental protection as their prime objective.

WHC supports projects that encourage selective logging within riparian zones, demonstrate biodiversity benefits from thinning programs, and demonstrate how clearcuts could best mimic natural disturbance patterns. This benefits the forest industry through maintaining a high quality wood supply; encouraging public support for stewardship activities that visibly achieve a variety of objectives; achieving many certification requirements; and allowing exemptions from many of the current generic guidelines. OMNR benefits through sustainable forest management at the operational level; an array of benefits for public funds; and future forest management plans that will include more than timber management objectives. Wildlife interests benefit through the opportunity to establish habitat objectives; and the opportunity to more effectively recognize performance and on-the-ground success with a more robust Forest Stewardship Recognition Program.

David stated that WHC supports IFM, provided that projects are managed and planned at a landscape level, sustain biological diversity within our forests, and establish habitat objectives for the forest management plans of companies participating in this program.

IFM – Implications for Wildlife and Biological Diversity

Robert Watt
Ontario Ministry of Natural Resources, Northeast Science and Technology Unit, South Porcupine, ON
(E-mail: bob.watt@mnr.gov.on.ca)

Bob stressed that IFM is less about the treatment than it is about the result. Intensity is measured as the difference between treated areas and natural disturbance, in terms of richness of composition and structure at a variety of scales. Intensive treatments are those that reduce natural complexity, and channel site resources into fewer components of the ecosystem (fewer species, fewer stems, fewer size classes), with a goal of increasing wood fibre production, using an agricultural paradigm.

The regulatory context for wildlife management comes from 2 sources, with 2 approaches. The Timber Class EA decision used a featured-species approach, managing for featured species in a particular forest type. For example, the moose (*Alces alces* L.) and pine marten (*Martes americana* Turton) are featured in the boreal forest, while the pileated woodpecker (*Dryocopus pileatus* L.) and white-tailed deer are featured in the Great Lakes – St. Lawrence forest. The CFSA requires that foresters emulate natural disturbances and landscape patterns. Forest management plans are required to be sustainable, in terms of biological diversity, and in terms of habitat for selected species of wildlife.

We conserve biological diversity on 2 ecosystem levels, by maintaining habitat diversity on the landscape, and by maintaining habitat for vulnerable, threatened, and endangered species, or ecological indicator species. We also maintain habitat for species such as game animals. To maintain wildlife habitat and biodiversity, we seek to emulate the landscape composition of the original forest, as determined from old surveys and inventories. Under natural conditions, we expect boreal forest age class distribution to follow a negative exponential pattern, with most individual trees in younger age classes, and exponential decline with older age classes. One third of individuals will be older than the mean fire rotation age. With intensive silviculture, we expect to see a shift to younger age classes.

The spatial arrangement of vegetation on the landscape has structure at several scales. Fires tend to burn large patches of forest, and within those large patches structure is provided by unburned areas and unburned features within burned areas. Although harvesting is done to emulate natural disturbances, clearcutting does not create the same conditions as fire.

There are fewer plant species, both of trees and minor vegetation, on intensively managed sites than in naturally disturbed sites. The structural features found in natural forests, including large trees, snags, cavity trees, coarse woody debris, multiple canopy layers, and horizontal structure are not present at the same levels in intensively managed stands.

A 3-year survey of forest birds provides a useful example of the potential effects of IFM on biological diversity. Different classes of birds have different niche requirements, and are better suited to different age classes of forest with different levels of site richness. Early successional specialists are most likely to thrive under intensive silviculture.

In conclusion, IFM may increase the risk to ecological sustainability, because the ecosystems it produces could be less complex. The degree of risk depends on the extent of the area treated, the spatial distribution of the treated areas (concentrated or diffuse), and the degree of difference between treated and natural areas. IFM can fit within a broader ecosystem management framework if we can find a home for protected areas and IFM zones within a larger landscape fabric.

It will require a more advanced level of landscape analysis and planning, and greater effort in emulating natural disturbances on the remaining land base. To mitigate the uncertainty associated with IFM, we should limit the total area devoted to IFM; actively monitor ecosystem responses; and use adaptive management to test multiple levels of intensity and compare the results with natural disturbances.

Economic Aspects of IFM in Ontario

Laurie Gravelines
Ontario Ministry of Natural Resources, Forest Management Branch, Sault Ste. Marie, ON
(Email: laurie.gravelines@mnr.gov.on.ca)

Laurie feels that IFM can have positive economic effects. It should increase employment, and will benefit non-industrial forest users if wood requirements can be met from less land. Higher quality and productivity of industrial fibre will benefit industry and reduce transportation costs. IFM should increase efficiency by increasing stand productivity.

Investment analysis can be used to determine if economics are an impediment to IFM. The costs and benefits of a project must be evaluated in a business case. Private and public sectors differ in their accounting stance, because they have different roles and different priorities. In the private sector, benefits, especially revenues and costs, including capital and operating, are weighed in the business case. The public sector will also include social values (recreational or spiritual, for example) and social costs (congestion costs, for example) in the business case.

Private companies are under pressure to produce quarterly profits, while public companies can take a long-term view and may have legacy considerations. Private sector companies operate to maximize share value, as demanded by shareholders. An investment in IFM is analyzed in the context of existing manufacturing investments, and must meet the company's usual threshold rates of return.

Using the stand as the scale of analysis, IFM expenditures are made now, and benefits are realized at some time in the future when the stand is harvested. Private sector business cases always fail in Ontario at the usual commercial discount rate of 15%. When the investment rate of return is 15%, the required return is over $800 at 50 years for every dollar invested.

Sustainable management uses the forest as the scale of analysis; rationing harvest from the forest, based on productivity. At this scale, IFM expenditures are made now, and the benefits are also realized now. The allowable harvest is adjusted to reflect expected gains, even though there are no changes in productivity yet. There are benefits to the forestry sector with this kind of analysis. Unlike stand-level analysis, a business case may support investment at the forest level.

There are several ways to finance IFM. IFM investments that increase the sustainable yield will increase the allowable cut. Assumptions made in sustainable yield modelling will have to be supported by science, consolidating and incorporating existing knowledge, and pursuing new knowledge. For example, increasing the allowable cut will require that we have confidence in the forest inventory.

A partnership between the public and private sector to finance IFM will benefit both sectors. The private sector finances IFM to their benefit in accordance with the private sector business case, while the public sector "buys" social benefits according to the public sector business case. The costs of IFM can be negotiated and divided between sectors, reflecting the distribution of benefits and costs.

One way to finance investments in silviculture is to make the investment a mandatory cost of doing business. This is done in Ontario through the Forest Renewal Trust. The private sector business case focusses only on whether the cost is justified as an expense to operate the mill. It is not viewed as an investment in silviculture. No public sector business case is needed. An older model is to have the government deliver silviculture. This is subject to the public sector business case only. It can be delivered through contractors (the Forest Management Agreement approach) or directly by government staff (an even older approach).

IFM decisions will require the ability to forecast industrial timber values over the investment period, a benchmark of existing non-timber values, and a knowledgeable basis to forecast future non-timber values.

Summary Speakers

Bob Carman
Provincial Forest Policy Committee
(Email: bcarman@gpc.ca)

The major issues for the provincial forest policy committee in 1999/2000 are IFM and tenure. As a member of this committee, Bob took this opportunity to point out the timeliness of this conference and indicated that he will be watching future progress in IFM with great interest.

Bob noted that we still need a significant amount of research and improvement in our knowledge of growth and yield and

related models but it's time to get on with our business and, as Bill Towill and David Archibald put it so well, implement what we already know and be proud of the results. It's time to practice common sense and take opportunities where we find them.

Overall, technology transfer needs to be better funded in the province. In the past, new foresters had the opportunity to travel across the province and learn the business in the field, on the ground. This is no longer the case, therefore we need to communicate best practices in other ways.

Instead of looking at silvicultural activities as a snapshot in time in terms of cost, we need to look at them from harvest-to-harvest, in terms of total delivered wood costs to the mill plus commitments under Timber EA, i.e., the environmental costs.

Bob wanted to go on the record as not being in favour of monocultures. IFM means something quite different; for example, commercial thinning in riparian reserves, shelterwood management, etc. In the future, IFM will be practiced on more than just special supply areas.

Who will pay for IFM? The policy committee will be spending some time on this. Rod Carrow has prepared a report discussing some of the issues around who pays and tenure issues for the committee. It's clear that if industry is going to pay for IFM they will want to own the trees and not just the increase in growth; that is, reap the benefits of their efforts. And as growth increases due to better practices, there will be demand for more parks and protected areas to protect new areas of concern and currently underrepresented areas. Thus, there will also be social benefits. This is a dilemma for future discussions.

We will need to be more sophisticated in our Forest Management Plans to meet changing consumer demands over the next 20 to 40 years. For example, MacMillan Bloedel in BC recently announced that they were giving up clearcut logging to meet consumer demands. The *lighter-on-the-land* mantra will be magnified many times before those of you currently practicing forestry reach retirement.

Bob said he is alarmed about the 5-year nature of the announced funding. A more permanent long-term relationship is required for the assurance of a science partnership that will last for at least 50 years.

Bob felt that the workshop was an important contribution to the care and feeding of IFM, which is an important topic. He will be watching with great interest as we take it to the next stage.

Rod Carrow

Consultant (Email: rcarrow@netrover.com)

Twenty years ago a forest regeneration conference was held in recognition of a serious problem – the regeneration gap. This was an historical benchmark that resulted in enhanced planting and stock production programs, including the greenhouse container stock industry, across Canada. There are parallels with this conference in terms of intensity and importance. The timing is right.

Rod noted that we seldom have the opportunity to stop and take stock of where we are and where we want to go – this conference provided the opportunity to do this and hopefully will act as a catalyst for the future.

The future promises to be more complex. With the advent of sustainable development came sustainable forest management, product certification, and more vocal opinions and concerns of environmental and interest groups about forest management practices.

We have seen progress in the last 20 years. We realized that planting trees was not enough; vegetation management has become common practice and the use of density control is increasing. Foresters have always maintained that they could grow all the wood we need on half the land base if they practised intensive silviculture – but they never had to because we have had the luxury of historic wood surpluses. Forestry in Canada has been largely a nomadic exercise – just over the next hill there was always more wood, providing little incentive to intensify our practices. Now social, environmental, and economic pressures are combining to provide the incentive. The Forest Accord, with its forest science partnership and designated IFM areas on the land base, will provide the mechanism.

In breakout groups during the workshop, people focussed on the language of IFM and spent much of their time defining IFM and associated practices. Keep in mind that our target is volume recovery. The 2.4 million ha of productive forest in the province. The near-term science and technology needs associated with replacing that loss are where our focus should be.

IFM in the boreal forest includes practices commonly associated with basic forest management; i.e., site preparation, planting/seeding, vegetation management, fire protection, and pest management to prevent mortality, as well as more intensive practices such as the use of larger stock, mycorrhizae, precommercial thinning, pest management to reduce growth losses, stand conversion, and fertilization.

In the Great Lakes-St. Lawrence forest, practices are already pretty intensive but opportunities exist to expand the use of stand improvement, prune high value species, manage pests to control outbreaks, convert low quality stands, and expand existing programs to more of the land base.

Over the past few years, the Forestry Futures Trust has funded over 120 projects to the tune of $20 million – virtually all of them IFM related. As Phil Dougherty alluded to, the terrain we're driving through changes and sometimes we need a new wheel; there has been lots of good work done by the CFS, OMNR, and the universities that was ahead of its time and may now be worth revisiting. Gordon Baskerville once said that *CFS file cabinets are full of answers to questions no forest manager ever asked*. Now we're asking the questions. We need to synthesize, validate, and verify existing information and identify the gaps. Now is the time to dust off those databases, reports, and files.

Rehabilitating degraded stands can only be justified if the area will be protected and managed through to the next harvest. We need to define the criteria to be used to identify IFM areas. These might include FEC type, proximity to mills, and species matching.

In the absence of a larger framework within which to consider IFM, the province needs a long-term wood production strategy that considers social and economic benefits, and products and their values. More attention needs to be paid to high value wood and products.

A 5-year funding commitment to IFM is totally inadequate – it's a long-term issue that requires long-term support and security to achieve our goals.

Ontario's Living Legacy and the Forest Accord represent outstanding accomplishments for the province. Most of us are too caught up in the day-to-day crises of downsizing and cut backs to appreciate it, but it is significant – we have an unprecedented tripartite agreement and an accord with specific commitments. This represents an enormous opportunity, but also carries with it some responsibilities…for scientists to focus information needs to provide a credible, reliable database on which to base decisions…and for forest managers to put the information to work in practice. Science and forest managers need to work together to make this happen. Don't lose the opportunity. Rod's parting words were *the world is run by those who show up – those of you who chose to have the opportunity to run the forest management of the near future.*

Facilitated Session Methods

Following each of the invited speaker sessions (practices, applications, and social, environmental and economic concerns), 1 ½-to 2-hour facilitated breakout sessions were used to solicit participant input to meet the main goal of the workshop, that is *to identify what we currently know and what we need to know about IFM to adapt it for use in Ontario's forests*.

Participants were divided into groups of 8 to12 participants with the intent to have a mix of government, industry, non-government organizations, and First Nation representation in each group. In the end, there were 6 groups of individuals from the northeast region, 5 groups from the northwest region, and 7 groups from the southcentral region, ranging from 7 to 11 participants plus a facilitator per group (Appendix I).

Participants were charged with identifying the IFM-related science and information needs associated with each of the workshop themes. For example, in the *Practices* breakout session, participants were charged with identifying science and information needs as they pertain to (a) developing and testing a range of IFM practices, (b) assessing the impacts of IFM on increased forest growth and yield, and (c) supporting Ontario's forest management planning requirements under the Timber EA and CFSA.

Following the *Applications* session, participants were charged with identifying IFM science and information needs related to (a) directing science activities in support of Ontario's forest management planning requirements under the Timber EA and CFSA; (b) modifying existing policies where necessary; and (c) enhancing forest protection measures to protect IFM areas from fire, insects, and disease.

In the *Social, Environmental, and Economic* breakout session, participants were charged with identifying science and information needs related to (a) assessing the impacts of IFM on the environment, (b) directing science activities in support of Ontario's forest-management planning requirements under the Timber EA and the CFSA, and (c) evaluating the monetary costs and benefits of IFM.

The workshop did not explore other strategies, such as ecosystem management, private land forestry, or non-wood fibre production, which may be pursued by Ontario to meet the need for more services and products from Crown forests.

The workshop focussed on science needs and did not consider broader issues such as global competitiveness, or long-term social and ecological implications.

Facilitators were instructed to discourage discussion on issues that, while important to forest management as a whole, could easily distract discussions away from the workshop objectives. These included:

- definitions of intensive forest management or intensive silviculture
- tenure
- alternative means of addressing wood supply shortages, such as utilization, non-timber fibre sources, etc.
- job creation
- tariffs and trade
- value-added products, tertiary manufacturing, and non-timber products

Discussions were to be focussed on the "area of the undertaking", although there was consideration given for discussion about private lands in the Southcentral Region sessions. All of the discussions were captured by the facilitators and summarized in a series of tables.

Facilitated Session Results

The results of facilitated session discussions, that is the combined responses from all the participants, are summarized below. Details are provided in tabular format in Appendices III - VII.

I. Developing and Testing a Range of IFM Practices

Through the course of discussions, most working groups came to the realization that:

(1) a fair amount of experience, knowledge, and information exists about a wide range of forestry practices on various sites, but is not readily accessible to the practitioner,
(2) wide discrepancies may exist between current practices and the present state of *best practices* knowledge,
(3) new science is needed in several areas, but, for the most part, answers will be long term; some action must be taken before all the results are available, and
(4) given (3), it is imperative that baseline and treatment responses be documented so that practices can be improved over time.

With these realizations came some general recommendations for enhancing our forest practices knowledge, which can largely be summarized as an *adaptive management* process (Figure 2). One of the first recommended tasks is the assembly and synthesis of existing knowledge and information. A single, on-line, interactive, electronic database could serve to warehouse existing knowledge and provide a key decision-making tool for planners and field personnel. Access by the general public could serve an educational role, if marketed properly. Construction of such a database should have a relatively short timeline of 1 to 2 years.

The electronic database would, based on existing knowledge, allow the identification of *best management practices* and guideline updates for forest regions, working groups, and sites. These would then provide a point of reference for forest managers. Given that a fair amount is already known about how various practices might affect different sites, and that it will take considerable time to acquire better knowledge, we may proceed with the implementation of our *best bets* with the full intention of monitoring and documenting progress. It is critical, therefore, that a sound and consistent program for silvicultural effectiveness monitoring (SEM) be implemented. Such a program would provide a mechanism for increasing our knowledge base and fine-tuning processes and is the essence of *adaptive management*.

In addition to providing a concise overview of what we know, the electronic database would serve as a gap-analysis tool in identifying where we should focus our research efforts. Research may consist of further synthesis of existing experimental data (e.g., meta-analysis of data from a number of related trials to address broader questions), the remeasurement of relevant existing experiments (with extrapolation to various climatic and geophysical zones of Ontario), and the establishment of new trials. Fairly rapid knowledge gains might be made from the former efforts, whereas results from new research may not be available for one or more decades. Because of this long timeline for new data, it is important that we anticipate the questions we will be asking 20 years from now and establish experiments to address those questions. Several participants also emphasized that new research should strike a balance between basic and applied aspects, and focus on multi-factor treatments across soil types of interest.

The above overall recommendations provide the context for more specific recommendations relating to individual practices summarized below:

Silviculture systems: Mats Hagner's emphasis of the need for increased wood quality and its acquisition through multistoried stand management and thinning-from-above provoked much discussion in the breakout sessions. It is clear that silviculture systems involving continuous forest cover are more palatable to the public than clearcut systems. Thus, such systems would be particularly attractive if they could be designed and demonstrated to produce high quality, solid wood products at acceptable production rates. In the breakout sessions, Southcentral Region discussions focussed on refining the single-tree selection and shelterwood systems that have been implemented on a wide scale over the last decade. The need for calibrating stand-structure targets (J-curves) to site and refining group-selection methods for encouraging mid-tolerant species were cited as high priorities. Quantifying the response of degraded stands to improvement treatments (i.e., improvement cutting, girdling, individual-tree herbicide applications, etc.) and encouraging the use of these treatments (e.g., through improving markets, subsidies, and legislation) were also ranked highly. Participants from this region also noted the need for improved harvesting equipment and systems, better suited to partial cutting, that minimize damage to residual growing stock. Although some work has been done on the extent and effect of logging damage to crop trees and advanced regeneration, more effort was called for. Tools for managing winter-logged areas with poor access are also needed, particularly for site preparation and tending in white pine stands.

In contrast, the northern groups discussed how selection and shelterwood systems might be used for mixedwood management. Some of the scenarios debated included the gradual conversion of low-quality hardwoods to higher quality, shade-tolerant softwoods, the management of 2-tiered stands (e.g., poplar (*Populus* spp.) and white spruce (*Picea glauca* (Moench) Voss); jack pine (*Pinus banksiana* Lamb.) and spruce), and strategies for upland and lowland black spruce (*Picea mariana* Mill. B.S.P.), and tamarack (*Larix laricina* (Du Roi) K. Koch). Other knowledge gaps included the implications of uneven-aged management on aspects such as genetics (e.g., a better understanding of the viable breeding population and pollen flow), windthrow losses, successional pathways, and forest-insect pest interactions.

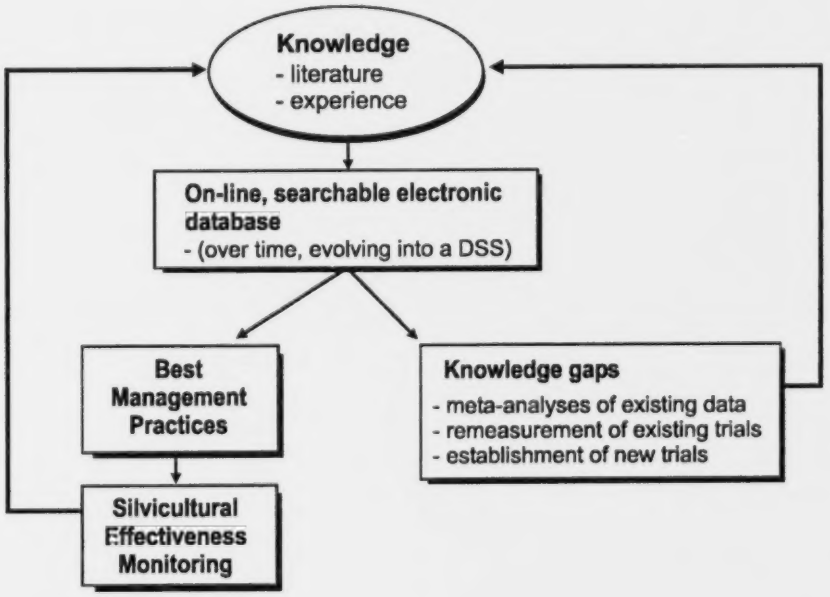

Figure 2. Adaptive management process for enhancing silvicultural practices.

Discussions surrounding clearcut systems focussed largely on the use of seed trees for achieving natural regeneration. Better guidance on the required number of seed trees and their distribution (scattered vs. clumped), by species and site type, is desired. There is also a need to tmaintain structure in clearcut systems; how this can best be achieved using residuals, and what the management implications are, remain as outstanding questions.

Harvesting: As mentioned above, the development and testing of specialized equipment for partial harvesting (i.e., selection, shelterwood, 2-tiered stands, etc.), and minimizing damage to residual crop trees, advanced regeneration, and soils, were identified as priorities. Also consistent with the desire to explore uneven-aged management in boreal mixedwoods is the need for appropriate harvesting techniques (e.g., removing aspen first). Several groups representing the northern regions cited the need for selection harvest options for riparian zones. Other needs noted by participants include better utilization technology (e.g., chipping of small diameter stems), use of geographic positioning systems (GPS), point-of-harvest training and education of operators, and the development of long-term spatial harvest models. A simple, important contribution to the inventory and mapping of site productivity could be achieved by linking harvest volumes to locations. Although perhaps not a science and information need, several groups called for better integration of harvesting systems and silviculture, so that the harvest can be planned and executed to better facilitate regeneration.

Site preparation: The use of prescribed burning dominated site preparation discussions. In general, there is the sense that better use could be made of fire, provided costs can be reduced and the tool made more accessible (e.g., through more flexible and less restrictive policies and guidelines). To achieve this, work is needed in the area of identifying optimum site, stand types, forest conditions, and burn conditions with greater accuracy. Many felt that fire could have a role in pre-harvest site preparation, mixedwood and multi-storied stand management, or in combination with practices such as planting large stock and herbicide application. Fire could also be an important tool for the regeneration of high-value species such as red oak and white pine, if current barriers to its use could be relaxed. In terms of mechanical site preparation, participants cited the need for better operator training, particularly with respect to applications on sensitive sites and heavy soils. Further, we should try to identify circumstances where sites can be effectively hot-planted after harvest, without mechanical site preparation.

Regeneration: Selecting the species / stock type / seed source best suited to the site and then applying the optimal silvicultural strategy for this combination was widely identified as an area that requires more consistency. To achieve this consistency, a research database of treatment responses by species and site is needed. This could be initiated by compiling existing data and constructing a searchable electronic data bank (Figure 2). The data bank would be updated using data from silvicultural effectiveness monitoring programs and augmented with data from research trials designed to fill specific knowledge gaps and explore new technologies and ideas. There is also a need for greater understanding of the limiting factors on our sites, so that specific remedial treatments can be targeted to optimize growth. Practical strategies are also needed for the renewal of mixedwoods, including mixed species plantings (e.g., black and white spruce; black spruce and jack pine), underplanting, and integration with natural regeneration. Several participants emphasized the need for a better understanding of tamarack nursery production and subsequent silviculture, along with several other important, but less common species including basswood (Tilia americana), white ash (Fraxinus americana), black cherry (Prunus serotina Ehrh.), red spruce (Picea rubens Sarg.), eastern hemlock, yellow birch, and eastern white cedar. Some groups felt that there were still gains to be derived from nursery cultural practices and a better understanding of how these interact with subsequent silviculture (e.g., mycorrhizal inoculation, different stock options, including clonal cuttings, hot planting without site preparation, etc.). Operationally, there may be large potential gains in simply ensuring adequate stocking on sites and using refill and in-fill planting where necessary.

Tree improvement: Genetics have offered strong growth responses in other jurisdictions and many feel it should be looked at with greater interest here in Ontario. There is a need to revisit and revitalize Ontario's tree improvement program, including assessment of the status of existing orchards, collection and analysis of data from 1st generation orchards, the establishment of new seed orchards, and research to bridge the gap to 2nd generation orchards. The gains and ecological consequences of genetic manipulations to enhance aspects of wood quality and resistance to disease and insects is a large area that needs study. Similarly, the gains and

ramifications of clonal plantings (e.g., veneer quality hardwoods) should be addressed. There is also an important need to study the interactions between genetic improvements and various silvicultural practices (e.g., vegetation management, thinning, and fertilization). In all of this, public education and buy-in should be proactively pursued.

Vegetation management: Despite more than a decade of experience with the use of herbicides, there is still an important need for greater understanding of the optimum timing, extent, and duration of weed control under various site conditions. This ties in with the need to understand the growth-limiting factors on our sites, mentioned above. For example, will an increase in the extent and duration of weed control free up enough nutrients to mimic fertilization? Data describing long-term growth responses to vegetation management are scarce for Ontario and efforts should be increased to document existing studies and establish new trials with long-term objectives. Participants also cited the need to take measures to ensure that chemical vegetation control remains an available tool, including documenting long-term sustainability factors and increased public education and awareness. This being said, efforts should also continue towards the testing and evaluation of non-chemical vegetation management alternatives (e.g., bio-controls and silvicultural methods). Participants also called for more efficient herbicide application technology (ground application in particular), better applicator training (including basal bark applications of triclopyr), and the ability to apply tank mixes of registered products. Special needs exist for the development of vegetation management options for white pine management.

Density regulation: Precommercial thinning (PCT) and commercial thinning (CT) were widely felt to be among the best opportunities for reducing rotation ages and increasing piece size and quality. There is a fair amount of published and unpublished data on thinning and one of our first priorities should be the synthesis of this existing data, perhaps in the form of a searchable electronic database and meta-analyses to begin the construction of managed-stand growth and yield curves (Figure 2). Questions such as growth responses to PCT, the applicability of PCT to black spruce and tamarack, appropriate regimes for aspen, and achieving sawlog and veneer production from mixedwood stands through thinning may largely be addressed by existing data. Questions related to CT will require a systematic program of silvicultural effectiveness monitoring, designed experiments, and adaptive management. From these efforts, we need to develop and substantiate site- and species-specific density management diagrams and crop plans, as well as further our understanding of how these sequences of treatments affect wildlife habitat. Potential for thinning-from-above, promoted by Mats Hagner, should also be explored for our species, particularly the mid- and shade-tolerants. Cost-benefit analyses of all aspects of thinning are needed. In addition to a better understanding of how best to implement thinning, participants widely voiced the need for more effective and efficient tools and equipment, coupled with heightened operator training and situational awareness. There is also interest in the use of herbicides to augment mechanical or manual PCT.

Pruning: Although pruning can be costly, many participants felt that this practice deserves local evaluation for its potential to improve product quality and value. Trials should include full economic analysis and well as study of the interactions with insects and diseases.

Fertilization: As we gain increased understanding of the limiting factors of our sites, we will want to take mitigative measures to increase growth, where it is cost-effective to do so. Fertilization is widely used in other forest regions to boost productivity and reduce rotation age. Some trials have been conducted in Ontario and participants felt it important to revisit the circumstances and results of this work and conduct a problem analysis to determine whether nutrient management could have a role here. If warranted, trials should be designed to quantify growth responses and costs, effects on wood quality, the nature of interactions with other silvicultural treatments (e.g., vegetation management), interactions with insects and disease, and effects on the ecosystem and environment. The social acceptability of fertilization is something that should be addressed proactively.

II. Assessing the Effects of IFM on Forest Growth and Yield

While development of benchmark yield curves and succession models for natural and density-regulated forest conditions are high priorities in each region, the effects of IFM practices on forest growth and yield were recognized as a fundamental information gap in Ontario. Invited speakers recommended: (1) committing to a fibre target on a continuous, long-term basis, (2) further developing and maintaining a plot-based inventory system for Ontario permanent sample plots, and (3) developing and maintaining a silvicultural database. Participants echoed these needs by recommending the following:

Making a long-term commitment to growth and yield: Many participants recommended a long-term commitment to acquiring growth and yield information. Knowledge and information requirements identified by participants included accurate, locally calibrated (region-, subregion-, and FMU-specific) yield curves for the full spectrum of silvicultural treatment options. These curves should be based on forest units and ecosites.

Yields from mixedwoods, an important component of Ontario's boreal forest, were of interest to one northwestern Ontario group. Theoretically, mixedwoods should provide more biomass than pure stands because of compensating use of resources such as light, nutrients, and water. Actual mixedwood yields are not known for Ontario and yield curves traditionally developed for single-species stands are not applicable to mixedwoods. Better understanding and, eventually, accurate predictions of boreal mixedwood development and yield potentials are needed to implement IFM.

Successional pathways, linked to growth and yield curves, are important inputs to SFMM (Ontario's strategic forest management model). Reliable predictions of successional pathways require knowledge of stand composition after harvest, successional pathways for undisturbed stands, and successional trajectories for managed stands. Information about all of these components is needed.

Linking growth and yield to sub-regions and site types: Many participants recognized that site-specific information is required for effective IFM. The current forest ecosystem classification (FEC) system could serve as a foundation to examine the effects of silvicultural treatments on growth and yield. Quantitative estimates of site potential (site index) need to be investigated for a variety of species and linked to FEC type. Where IFM practices are applied, long-term soil productivity assessment and monitoring programs should be established.

Determining managed stand yield: Participants emphasized the need for accurate growth and yield information related to IFM practices. Most, if not all, yield information in Ontario is based on naturally established stands. Yields of plantations established with improved stock, using effective vegetation management, have yet to be determined. Yield predictions built into SFMM need to be documented and include locally calibrated data.

Participants specifically pointed to the need to study the effects of partial harvesting and thinning on yield. Refining partial harvesting of natural stands to improve yield and product quality is a long-term goal. This is especially true for tolerant hardwood and white pine management in the Great Lakes - St. Lawrence forests. Partial harvesting is a challenge in the boreal forest, but may be beneficial for establishing shade-tolerant species such as white spruce and eastern white cedar. Precommercial and commercial thinning are used to regulate stand density so that higher-value products can be realized in a shorter rotation. Although naturally established jack pine is often thinned in Ontario's boreal forest, the effects on growth and yield have yet to be quantified.

Many IFM practices may increase total yield, but reduce wood density and hence product quality. Other IFM practices may improve product quality and/or shorten rotation length at the expense of total yield. Quantitative information is required about the effects of various IFM practices on product quality and rotation length to improve our decision-making capabilities. Thus, we need to embrace and support a quantitative silvicultural program.

IFM practices may also increase the vulnerability of forests to insects and disease. This raises important questions: Will IFM practices increase the vulnerability of trees to cull, root rot, butt rot, and/or insect attacks? If so, are there adequate preventive measures? This is a huge information gap. Before implementing IFM on a large scale, interactions between damaging agents and IFM practices must be evaluated.

Adopting a rigorous scientific approach: Whether revisiting old trials or establishing new trials, programs and projects need to be peer-reviewed to ensure a rigorous scientific approach is used to gain reliable knowledge and information. At the operational level, the adaptive management approach may be useful for dealing with management uncertainties.

III. Directing Science Activities in Support of Ontario's Forest Management Planning Requirements Under the Timber EA and CFSA

Participants generally agreed that programs supporting science, technology development and testing, and information transfer must be maintained. Broad areas requiring more information include:

Developing criteria for selecting IFM areas: For each factor (legislative, policy, social, ecological, economic) used to select IFM areas, a list of quantifiable criteria are required, and each criterion (landscape productivity, wildlife habitat supply, vulnerability to disturbance, susceptibility to pests and diseases) needs to be examined for its status quo with respect to spatial information, databases, scientific knowledge, and tools/models/analytical techniques. Information gaps need to be identified and a strategy developed to acquire the necessary data.

Synthesizing current knowledge and identifying information gaps: Assembly and synthesis of existing knowledge and information into a database was highly recommended. Existing and new science partnerships should facilitate the gathering of data from past trials and studies that relate to key IFM questions.

Developing more precise wood supply inventories: Enhancing research on intensive silvicultural practices, expanding the permanent sample plot network, developing benchmark yield curves and succession models, and protecting areas from fire, insects, and disease were emphasized by almost all participants.

Developing harvesting and silvicultural techniques and silvicultural strategies: We need to select the best practices for each species/site combination using good rationale and identify associated knowledge and data gaps. Research efforts and gathering of existing information should emphasize plantation establishment and tending. Integrated practices may hold promise for good return on investment.

Improving growth and yield models: The permanent sample plot (PSP) network needs to be extended to include intensively managed stands. A plot network that addresses canopy trees as well as advanced growth and seedlings, and that accounts for height, diameter, and basal area would be ideal. Research on wood quality, including specific gravity and fibre length, both important to pulp, and diameter, knot size, and height, all important to sawlogs, should be linked to the full suite of harvest-to-harvest practices, rather than a single treatment. Benchmark yield curves and succession models for the full range of stand conditions (natural, extensive, basic, intensive, and elite silvicultural scenarios) can be developed with data from the PSP network.

Developing and testing protection strategies: The development of practices, such as prescribed burning, to minimize wildfires, and the manufacture of equipment to salvage burned timber would increase available fibre. The development of forest-level fire management planning tools should be encouraged. Research opportunities also exist to develop improved methods and products for pest control.

Conducting environmental research: Future science partnership efforts should focus on impact and sustainability questions, especially the effects of temporal and spatial distribution of IFM areas on non-timber values. Specific concerns around the implementation of IFM include potential effects on: (1) biodiversity at landscape and stand scales, (2) wildlife populations and habitat; (3) long-term site productivity (e.g., nutrient and soil carbon cycling), and (4) quality and quantity of water from forested watersheds. Research should include comparative studies with unmanaged forests as benchmarks or controls. Research, inventory, and monitoring projects should address the *how and why* of a response, rather than just describing what occurred. Research should address basic mechanisms rather than being solely empirical.

Conducting socio-economic research: Participants recommended 4 broad ideas for increasing social and economic research in forestry. They involve: (1) establishing a program of research and technology transfer that will help forest managers understand the expectations of the Ontario's citizens and consumers of Ontario's forest products; (2) determining forestry practices that are compatible with public expectations and ways of improving our communications about the practices; (3) increasing organizational support for research, education, and technology transfer on social aspects of IFM and related concerns; and (4) developing tools to help forest managers evaluate the effects of various forest management strategies on subsistence use of natural resources.

Enhancing transfer and training opportunities: Transferring related current knowledge through frequent information sharing sessions was deemed essential, both within and among organizational sectors—government, industry, interest groups—to keep communication flowing. In addition, we need a more responsive research community that provides timely feedback to field personnel.

IV. Modifying Existing Policies/ Guidelines

When discussing policy issues, participants echoed the need for a consistent, agreed upon working definition of IFM and a glossary of related terms. Among participants, the prevailing view of IFM is that it means *practicing forestry better*; i.e., ensuring logging damage is limited, new stands are fully stocked; and spacing and thinning are done at appropriate times. Any revisions of the suggested definition of IFM should include:

- goals for improving stand and wood quality as well as yields,
- a focus on sawlog (or other higher quality) products, and
- the obligation for practitioners to monitor IFM treatments.

OMNR and forest industry need to commit to IFM by modifying existing policies and guidelines to support IFM and accommodate adaptive management. Related concerns included the need for a more efficient, responsive process for changing legislation and/or guidelines; more flexibility and less regulation in the application and interpretation of these policies; and more dynamic guidelines. The involvement of stakeholders (e.g., First Nations, environmental organizations) in policy development was seen as key. Areas of policy noted as requiring immediate attention were identifying IFM zones and implementing IFM on degraded sites over the long term.

Many participants pointed to the need for a review of current policies, especially those that may inhibit the implementation of IFM on Crown lands in Ontario. Policies impeding IFM included those too rigid for effective implementation (e.g., CFSA and FMPM); those that discouraged innovation by requiring too much (often redundant) information acquisition, or specifying inappropriate means of data collection and presentation; and those assessing excessive stumpage rates.

Tenure: For IFM to be implemented as part of day-to-day business, it's clear that SFLs expect incentives such as tenure. As part of tenure, enhanced management areas (EMAs) must be established and delineated on the land base to protect investments and allow long-term return. The cost of financial incentives for IFM could be covered by creating a new fund or by modifying an existing fund (e.g., the Forest Renewal Trust). Subscription to this fund could be added to the stumpage fees. Alternatively, investment in IFM could be made more attractive to the forest industry by creating large concentrations of IFM working areas throughout the landscape. This would require rezoning and land use designation for IFM.

Exemption process: Participants expressed concern that the onerous exemption process in forest management plans and requiring proponents to pay the full cost of exempt treatments stifles innovation. This process needs to be streamlined and embedded in an adaptive management system. For exemptions to treatments prescribed under the Timber Class EA, practices common in other jurisdictions could be considered differently from untested silvicultural treatments since some information about their consequences is available.

Stumpage relief: Stumpage relief (or other compensations) should be provided for areas where industry is implementing new and more expensive silviculture technologies. Similarly, forestry trust funds should support contractors involved in IFM to acquire and develop softer technologies and skills. These incentives would need to be applied in a way that precludes subsidy allegations.

Planning tools: There is a requirement to understand IFM effects on wood availability from the remaining land base, *i.e.* are there targets for IFM areas that are not being met? The issue of fibre production *vs.* wood quality still needs to be resolved. To make appropriate IFM-related decisions, tools for more efficient planning are needed. Better integration of forest management planning with landscape ecological planning; e.g., in the layout of parks, the adjustment of forest management unit boundaries, and the assessment of wildlife and fire effects, would help managers reflect a desired composition at landscape levels. Other planning requirements include:

- better access to IFM areas;
- more confidence in the analysis used for ecological benchmarks in forest management plans and an appropriate scale for determining these benchmarks;
- consideration of preharvest site prescriptions (PHSPs) to promote IFM;
- lengthening the planning cycle to assist IFM implementation;
- consideration of the size of clearcuts, and the 1000 ha maximum; and
- a geographically based tracking system for spatial record keeping.

Integrated tools that facilitate forest management planning, such as SFMM and SEIM (socio-economic impact model) should be revised to work together. We also need models that can be integrated with DSSs used in other provinces. For a

number of these planning tools, including SFMM, yield curves and stand density diagrams (SDDs) are insufficiently developed to effectively support IFM. They require modification and more information, especially to support the management of non-traditional species. However, predictive models are only tools. There is risk in placing too much faith in *virtual* volumes, populations, and values.

Participants noted that SFMM does not adequately support conditions and species in southcentral Ontario. As well, more up-to-date inventory, better stand information, and greater knowledge of the effects of IFM are needed for effective planning. Before SFMM is developed further, variables must be refined, assumptions tested, and adjustments to yield curve standards justified before they will be accepted by forestry practitioners. More *bells and whistles* are **not** needed; more substance is. Some of this, for example the relationship between commercial thinning inputs and responses, will come from data collected as IFM is implemented. Working selection system inputs and outcomes into the model will help to make it more relevant to southern Ontario forest conditions and treatments.

OMNR needs to revise the Forest Information Manual to make the following forest cover attributes mandatory: stand origin and history, density class, and understory composition. This information would facilitate growth and yield modelling and land base description.

Tree-cutting bylaws need to be amended to allow the removal of low quality tolerant hardwoods to ensure the future annual allowable cut (AAC) available to SFLs from private lands is not reduced.

Harvesting, silviculture, protection, and wildlife habitat guidelines: Harvesting, silviculture, and protection guidelines were the subject of much discussion at the workshop. Participants concluded that there are too many complicated silvicultural ground rules. In addition, excluding fertilization, drainage, commercial thinning, and exotics (specifically the Timber EA); restricting pesticide use and prescribed burning; and lack of direction about genetically modified organisms (GMOs) will all negatively affect the implementation of IFM.

Harvesting in AOCs: Policies rendering areas of concern (AOCs) and reserves (i.e., highway corridors and riparian zones) inaccessible to harvesting were debated. Although more specific direction and detailed requirements for harvesting in reserves are needed, flexibility would be more conducive to IFM. Most participants felt flexibility was necessary to implement harvesting in reserves. However, one group felt that district policies on harvesting in highway reserves should be consistent.

Several participants were adamant that policy and guidelines for harvesting in riparian areas be reconsidered and modified. Maintaining fire origin ecosystems in riparian areas was recommended. Specifically, riparian and water quality guides should be modified to allow harvest and prescribed burns to extend to the shorelines, comparable to a natural event. Existing requirements for a complete lake survey should be dropped. Furthermore, the configuration of these reserves should be reassessed. Research needs to be conducted in a range of stand types to determine how to harvest in riparian reserves with minimal risk to aquatic and fisheries habitat. Identification of critical fish habitat that would lead to riparian zone buffers was deemed to be OMNR's responsibility (cost and staffing).

The need for certifying and/or licensing of operators conducting careful logging around advanced growth (CLAAG) and operating on sensitive sites was also raised.

Silviculture guidelines: Modifying silviculture guides was considered key to accelerating IFM implementation. Collaborative target setting and innovation needs to be encouraged, and the guides reevaluated to separate recommended and ill-advised practices. IFM practices that may be beneficial should be investigated, and the results tracked into new silviculture guides. The managed species list should be expanded to include white spruce, balsam fir, cedar, and white birch (*Betula papyrifera* Marsh). Ecosite-based guidelines need to be developed for black spruce, old growth pine, and jack pine management. Missing ecosites (*e.g.*, upland cedar) should be identified and appropriate guidelines completed. Other ecosites (*e.g.*, shallow soil/hardwood) should be redefined. Commercial thinning guidelines also need to be developed.

There is a requirement for clear and acceptable prescriptions that consider and accommodate features affected by IFM (e.g., water quality, riparian code of practices, cultural heritage guides, resource-based tourism, aesthetics). As well, the cumulative effects of guidelines, how they interact, and whether they conflict must be considered and documented.

Silviculture ground rules (SGRs): In their present form, SGRs are not considered suitable for IFM. Even though SGRs allow some flexibility, that flexibility has to be built into the planning system (*i.e.*, through adaptive management). More process is not needed; entrenching in practices both

adaptive management and effective monitoring/feedback is. Similarly, the development of appropriate data collection tools for SGR preparation is required, as is technology transfer to ensure they are avilable and being applied consistently.

Other modifications suggested for existing silvicultural guidelines include justifying yield curve adjustments; stiffening policy enforcement; improving physical site disturbance guideline definitions and standards; enhancing consistency of tolerant hardwood marker and operator practices; and enabling IFM to emulate natural disturbances—for example, existing guidelines conflict with the EA on the size of clearcuts permitted.

Specific recommendations were also put forward for the following practices:

Prescribed burns: Current policies make prescribed burning (PB) too expensive and too onerous for most forestry practitioners — the time and amount of planning required for a small burn in the Great Lakes - St. Lawrence (GLSL) forest region is the same as for a large burn in the boreal forest. In the GLSL, a delivery mechanism for prescribed burns is lacking; the outcomes are costly and uncertain. The PB process should be streamlined and guidelines and priority setting for GLSL forests revised. Planning processes and training guidelines for GLSL understory burns should be updated. Current policies and guidelines should also be modified to take advantage of wild fire (*i.e.*, 'managed' wild fire) to achieve IFM. Practical alternatives are needed for conditions under which burning becomes impossible, for example, exploring the use of chemical herbicides as an alternative. The cost and liability of prescribed burns should be shared equally between the proponent and the government.

Stocking and regeneration: Current stocking and regeneration standards need to be revised for IFM planning teams. Similarly NSR standards need to be revisited in the light of IFM. They include:

- natural regeneration of mid-tolerant species (e.g., red oak, white pine);
- regeneration of species mixtures (*i.e.*, jack pine, white spruce, aspen, black spruce, tamarack, and intolerant hardwoods);
- use of cover crop trees if needed; and
- management of 2-story stands towards uneven-aged condition.

Vegetation management: IFM will require improved, and possibly more intensive, vegetation management treatments. Mixing of chemical herbicides and the necessary changes in the registration of herbicides will need to be pursued and monitored.

Density regulation: Guidelines that promote thinning through enhanced yield share allocation and/or reductions in stumpage need to be developed. To ensure that this treatment is carried out well, a set of charges for crop tree damage during thinning (PCT or CT) or selection harvest should be established. A few participants suggested formalizing and regulating training for thinning practitioners and potentially making use of density management diagrams (DMDs) mandatory.

Protection Guidelines: Existing protection measures may not be adequate for IFM. Although fire detection technology and response in Ontario are reasonably effective, insect infestation and disease monitoring are inadequate. Protection guidelines are needed that reduce risk and ensure effective reaction to outbreaks. Participants identified the following enhanced protection needs:

- increased data collection to provide security through early detection,
- scientifically sound feedback on control treatments,
- 2-level monitoring—early warning and extensive, and
- enhanced protection measures factored into growth and yield evaluations.

Legislation and policies are required to ensure access to the appropriate tools for dealing with insects and disease. Further development and greater reliance on biological insecticides will be required. As yet, there are no biological tools for control of non-lepidopteran species (*e.g.*, sawflies), and Mimic is not allowed for budworm control. Only a limited (and decreasing) range of treatments are available. This treatment range needs to be expanded. Monitoring and treatment guidelines for sites at risk of damage should be adopted and measures formulated to encourage SFLs to restore damaged stands to a set standard.

Policies and guidelines are required that support protection of IFM areas from insects and disease spreading from adjacent public or private lands where minimal or no pest management treatments are carried out.

Wildlife and Habitat Guidelines: Developing a better understanding of how IFM affects biodiversity and wildlife habitat requires the development of decision-support tools that allow managers to evaluate various IFM scenarios. There are

many specific requirements associated with IFM in relation to wildlife and habitat, including the need to recognize IFM as the priority use in some areas; set IFM as an acceptable rationale for guidelines exemption; and identify where information is lacking to set priorities for future research.

Suggestions from participants included developing terms and conditions for harvesting in AOCs (*e.g.*, riparian zones); optimizing AOC prescriptions; better defining acceptable practices in modified zones; and monitoring the effects guidelines restricting the use of partial cutting systems (selection and shelterwood) in AOCs.

We also need to reevaluate guidelines with spatial impacts (*e.g.*, marten, caribou) relative to proposed IFM treatments. One suggestion was to make habitat guidelines more flexible for IFM areas, perhaps by specifying alternate habitat or its design features, to optimize suitability while maximizing fibre extraction. Examining the draft caribou guidelines to determine how IFM would fit in, whether the caribou mosaic conflicts with proposed treatments, and conducting research to assess the effects of IFM treatments on caribou populations, were recommended as being important. Designing IFM areas to meet marten habitat requirements (10% minimum core) by identifying immediate, short-term effects of IFM treatments on marten habitat, and determining the kinds of silvicultural treatments that ensure good marten habitat by testing biological assumptions driving guidelines, was also discussed.

The need to review moose aquatic feeding guidelines in the Great Lakes - St. Lawrence region and update eagle/osprey guidelines was mentioned by a few groups.

V. Enhancing Forest Protection Measures to Protect IFM Areas from Fire, Insects, and Disease

Most of the discussion in the protection sessions centred around whether current protection measures would be sufficient to meet the demands of an IFM mandate and if not, then what science and information needs are lacking

Protecting the investment in IFM on enhanced management areas (EMAs) should not only be directed against natural catastrophic events, but against social impacts as well. Because of the larger investments in IFM, a higher intensity of protection for IFM areas will be required. A key question that needs to be answered is "who will pay for enhanced protection – government, industry, or someone else?" Accordingly, there is a need to develop a fire/insect/disease protection plan that will identify who pays for protection, and/or to develop an insurance plan into which licensees and government would both pay.

To increase and maintain fibre production on a reduced land base, it is imperative that existing forest resources be protected and that IFM practices not increase the risk of losses to fire, insects, or disease. An inability to forecast potential losses and protect wood supplies may lead to significant reductions in available fibre on an annual basis. There are several essential components required for intensive forest resource management and protection. Many of these components will initially require database development and manipulation, coupled with technology transfer, to help determine further information and research needs.

Forest managers will need a comprehensive inventory of forest species and potential pests. Past surveys in Ontario and information from the national pest database can be synthesized to provide an inventory of insects and diseases associated with tree species and current stand conditions. A current inventory of tree species by age, distribution, abundance, and condition in designated IFM areas will aid in the development of guidelines for future protection policies. Current insect defoliation data can be used to develop models to predict where and when anticipated outbreaks will occur.

A DSS to determine the cost effectiveness of protection, and an understanding of how fire, insects, and disease interact with tree species, will enhance the development of silvicultural strategies. DSSs calibrated to optimize harvest schedules and reduce fibre losses, or to optimize protection programs will be necessary tools for present and future forest managers. Existing DSSs could be modified for other forest insect pests and diseases. This information is the basis for decision making and refining existing protection systems.

Novel forest management strategies using an integrated pest management (IPM) approach, along with recent advances in biotechnology could be used to enhance protection of IFM-designated areas. Additional short-term research could produce improved IPM strategies.

Fire protection should be encouraged in IFM areas. The development of silvicultural practices to minimize wildfires, and the manufacture of equipment to salvage burned timber would increase available fibre. The use of controlled burns as a silvicultural tool should be encouraged in susceptible areas and for the overall benefit of forest health. Fire management planning in forest operations, e.g., landscape breaks and site layout, would reduce the timber lost to wildfire.

Insects and diseases have historically caused high losses to potential fibre production in both natural forests and plantations. Knowledge of pest problems and protection options are required in natural forests during outbreaks of major forest insects. Computer-based DSSs can assist in developing management plans that minimize losses either through protection of affected stands or through early harvesting. Plantations create some unique problems. These stands are sometimes more vulnerable to major insects and diseases as well as to those normally considered of lesser significance. In addition, because of the increased investment in silviculture, protection and the avoidance of pest problems are of even greater importance than in the natural forest. In these circumstances, pest impacts must be anticipated and integrated approaches developed to deal with these problems.

Products and approaches exist for a variety of pest management scenarios. Technology transfer will be an important part of implementing a sound IFM program. Research opportunities also exist to develop improved methods and products for pest control.

VI. Assessing the Effects of IFM on the Environment

Regardless of the extent of IFM, the effects of forest management on the environmental quality and ecological sustainability of Ontario's forests will continue to be significant social and political drivers of forest policy. There is an urgent need for more information about non-timber values in Ontario's forests, as well as new knowledge to assess and predict the potential effects of IFM on ecological sustainability at the stand, landscape, regional, and provincial scale.

Breakout group discussions of science and information needs relevant to IFM effects on specific environmental resources shared many common elements. A general sequence of activities to address the increased use of IFM emerged: (1) conducting a benchmark assessment of current resource status and associated factors, (2) developing research trials that address effects of practices at many scales and build on current knowledge (Ontario, Canada or elsewhere), (3) using adaptive management, (4) monitoring short- and long-term effects, and (5) using information to refine or develop models, decision support tools, guidelines, and/or policies. It was generally agreed that inventory, monitoring, assessment, and reporting on the status of non-timber resources (wildlife, biodiversity, soil/site productivity, water quality/quantity, etc.) are essential to the protection of environmental quality and ecological values of Ontario's forests.

Non-timber Values and Scale: The effect of IFM on non-timber values will depend on the size and spatial distribution (geographic location and soil/site/habitat type) of IFM areas across the landscape. Effects will vary with timeframe of reference and should be considered relative to the intervening extensive management areas, buffer areas, parks, and protected areas. Science efforts should therefore be directed to examine the environmental effects of IFM at both stand and landscape scales.

Non-timber Values: The short- and long-term ecological effects of ecosystem simplification on non-timber values are a significant concern. Natural forest structure may be sacrificed by IFM if current forests are replaced by monocultures or "tree farms". The effects of simplification are unknown, but will likely vary with forest type. Many Ontario forest types are naturally low in structural diversity. Research to determine the relationship of management intensity with ecological values is needed to protect non-timber values and should include comparative studies with unmanaged forests as benchmarks or controls. Results should be used to develop criteria and indicator thresholds for loss of sustainability and environmental quality. Information should also be used to develop models and other decision-support tools to assist in forest management planning and improving and/or revising existing policy and guidelines.

Wildlife: More specific science and information needs were identified during discussions of single non-timber resources. Research directed to quantify the effect of IFM on wildlife should focus on effects on habitat and numbers (populations) of wildlife both in a broad sense, and the effects of specific practices (e.g., precommercial thinning, prescribed burning) on specific wildlife species. Fundamentally, we need to understand the relationship between structure, age, and management intensity and its effect on wildlife habitat and populations. This information, and the spatial distribution of IFM areas and activities, should be used to develop models and other decision-support tools, policies, and guidelines and determine the effectiveness and future need for reserves and protected areas. Rare, threatened, and endangered species will require special attention (e.g., inventory, habitat requirements, monitoring).

Biodiversity: Concerns about the effects of IFM on biodiversity (landscape, species, and genetic diversity) arise from the view of some that IFM is not "natural", and will lead to a reduction in ecosystem complexity, decreased biodiversity and productivity, and creation of "biological deserts". Research is needed to quantify the effects of IFM on biodiversity at landscape and stand scales. This should include examining the

relationship between IFM and natural disturbance, and the effects of specific IFM practices as well as the spatial arrangement of IFM areas on diversity. Information should be used to develop IFM practices that maintain/enhance biodiversity across the landscape.

Soil / Site Productivity: There is concern about the effects of IFM, intensive silviculture, and associated equipment on long-term site productivity manifest through negative effects on nutrient and soil carbon cycling. Altered nutrient cycling and reduced productivity may result from fewer natural fires (due to increased protection) and infrequent use of prescribed burning. Research to quantify the effects of IFM on soil/site productivity should include effects on terrestrial and aquatic ecosystems. Information should be used to develop tools, guidelines, and policies to protect the physical environment and maintain soil processes and site productivity.

Water Quality / Quantity: IFM may affect forested watersheds and reduce the quality and quantity of water from these areas, with potential effects on aquatic ecosystems and local communities that rely on forests for water supply. At the stand level, concerns include the effects of partial harvesting on riparian buffers, road building/deactivation on sedimentation and water quality of streams, rivers, lakes, and wetlands, and the use of fertilizers and herbicides on aquatic ecosystems and water quality.

VII. Evaluating the Monetary Costs and Benefits of IFM

Cost/benefit analyses of treatment alternatives, including the status quo, are required to determine the optimum treatment package for various IFM objectives. IFM will have to pass such analysis, which may be difficult, given that there has been difficulty supporting even a basic level of silviculture in the past. The results of cost/benefit analyses will depend on the desired outcomes of IFM: shorter rotations, increased wood volume and wood quality, and protection of other forest values. The cost of IFM to the environment and to society must be included in the analysis.

The beneficiaries of IFM, whether they are industry (increased quantity and quality of wood supply, reduced costs, allowable cut effect), government (increased revenues, lower unemployment), or society in general (stronger economy, higher employment, more parks), should bear the additional incremental cost of IFM and the associated risk. There was a recognition that the growth benefit of any IFM treatment must be proven before allowable cut is increased.

Some participants suggested that if society (the Crown) wants to retain ownership of the resource, there will be a need to subsidize industry to practice IFM. Public investment in IFM will be determined by the citizens of Ontario and therefore may have a southern Ontario bias. Changes to tax laws to support IFM may be appropriate, but any such policies will have to be carefully written to prevent undesired outcomes (tax incentive effects) and challenges to the North American Free Trade Agreement.

Analytical and decision-support tools, especially models and databases, will have to be developed to weigh the cost/benefit of IFM projects, including those seeking resources from trust funds or the government. Data needs include:

- future macroeconomic outlook
- realistic future product markets and values, including value-added products
- cost of treatments
- treatment effects on future products
- short- and long-term wood supply consequences
- better growth and yield models, calibrated through long-term monitoring
- stand-level information for decisions about individual stand management

Other issues mentioned by participants included that research funded under the Ontario's Living Legacy trust should be compiled in a common database, with common standards for site description and data collection. Clarification of the meaning of "no net increase in the cost of wood delivered to the mill" and "unless agreed upon to the satisfaction of all parties" is required. Further, there may be increased costs associated with pest and fire control both because of potential predisposition caused by IFM treatments, and the need to protect investments.

The Forest Accord should not be the sole justification for IFM; it must be economically viable. IFM does not simply mean higher returns on existing investments; more money will need to be invested, requiring careful planning and allocation of funds. Higher returns can be achieved from forestry apart from IFM. Treating all sites at least at a basic level of silviculture, or ensuring that all sites are fully stocked with desirable species, would do much to obviate the need for IFM. Effectiveness and consistency of treatments are the keys to reasonable rates of return from forestry.

VIII. Social Aspects

Participants recognized the limits of their understanding of the social aspects of forestry, and that IFM may fail if the public does not support or actively rejects IFM. They recommended increasing social forestry research.

IFM is currently poorly defined; it means different things to different people. Its goal of higher wood quality and volume may be acceptable to many people. However, the types of practices used and their pervasiveness in the forest are of concern. For example, short rotation plantation forestry may be acceptable on some portions of a forest but are less likely to be accepted if they are used extensively.

Overall, participants recommended:

- Developing a clear definition of IFM in Ontario that captures accepted practices. The definition must also allow the public of Ontario and consumers of Ontario's forest products to recognize and accept which practices are allowed and which are prohibited.
- Establishing a program of research and technology transfer that will help forest managers to understand the expectations of the citizens of Ontario and consumers of Ontario forest products.
- Determining and communicating which forestry practices are compatible with public expectations. Successful examples of practices with less reliance on clearcutting and pesticides are available and in use in parts of Ontario and the Menominee Forest in Wisconsin.
- Increasing organizational support for research, education, and technology transfer on social aspects of IFM and related concerns.
- Developing tools to allow forest managers to evaluate the effects of different forest management strategies on subsistence use.

While not a science need, participants recognized that Aboriginal Peoples and residents of small rural communities need to be treated fairly in the process of planning and implementing IFM. IFM does offer opportunities for these groups. However, specific programs aimed at allowing these communities and people to build capacity have to be instituted. These programs should be matched to the unique needs of these communities.

Organizing Committee's Recommendations: The Next Steps

The above sections outline recommendations made by workshop participants as they relate to specific directives of the forest science partnership identified in the 1999 Forest Accord. The goal of the workshop was to identify science and information needs as they relate to these directives, which included developing and testing a range of IFM practices; assessing impacts of IFM on forest growth and yield; supporting Ontario's management planning requirements under the Timber EA and CFSA; modifying existing policies and guidelines; enhancing forest protection measures necessary to protect areas from insects, disease, and fire; assessing the impacts of IFM on the environment; and evaluating the monetary costs and benefits of IFM. While the facilitators did an excellent job of focusing discussions on these areas, it was clear that there were some broader issues that participants wanted to see addressed before or in concert with the science. Below, we attempt to capture these issues by presenting them as steps that are required in the development of an overall IFM implementation strategy. Several of these steps do not involve science and, as such, we present them at the risk of exceeding the scope of this workshop. In defense, these issues could have a significant influence on the direction and nature of future science activity and are, therefore, highly relevant.

Clearly, increased demands for fibre from a continually smaller land base will result in future wood-supply shortages in Ontario if intensified forest management activity does not occur. However, before forest management can be intensified on portions of Ontario's landscape, we must construct a strategic framework within which IFM can take place. Ontario's Living Legacy and the 1999 Forest Accord go a long way towards initiating this framework, but several key components must yet be completed:

Establish clear definitions for IFM

First, we must establish a clear, unambiguous set of definitions for IFM and IS. Currently, there are huge differences among professionals in what they envisage when they refer to IFM and even greater variance among members of the general public. To some, IFM means plantation forestry; monocultures; forests void of diversity; tree farming. To others, IFM means simply practicing forestry better; minimizing logging damage; ensuring future stands are fully stocked; spacing and thinning to ensure adequate growth. Others see IFM as a continuum, where forests are composed of a mosaic of species complexes that are managed under a range of intensities designed to achieve overall forest objectives. Such a diversity of views will create significant problems in the development of policy and legislation (e.g., there is huge debate about what IFM actually means in the 1999 Forest Accord alone) and the communication of subsequent decisions to the landowners (the public).

Develop provincial forest resource objectives and strategy

Resource objectives often conflict, policies and management guidelines may not support established objectives, and there may be no efficient framework in place for managing a given piece of land. Because of this, there appears to be no clear context for how IFM will dovetail with other provincial resource management priorities. Questions relating to why we are doing IFM, who will pay, who will benefit, what practices will be allowed and disallowed, etc., were voiced repeatedly during the workshop discussions – these issues must be addressed through a unified, provincial strategic approach.

Ontario needs to develop a clear vision and strategy for its forest land base as a whole. This would include the development of clear objectives and targets for the nature and quantity of values to be produced from our forests, within the context of a satisfactory agreement with our First Nations communities. The intent should be to market a mix of products from our forests, sustainable wood production being just a part of that mix. In establishing objectives for doing this, the province must retain the perspective of *landowner*, seeking to manage all lands for the greatest public benefit. With clear provincial direction in hand, all relevant policies, guidelines, and procedures must be reviewed to ensure their alignment with the overall objectives and strategy for managing our forest resource.

Each specific forest management plan should be written within the context of the overall provincial objectives and strategy and, as such, provide a framework for the SFL holder to manage in a logical and practical manner. In this context, IFM may be used to enhance timber volume and quality on some areas and non-timber values such as wildlife and recreation on others. However, the management objectives for a given area need not be static. As a particular forest grows and passes through various life stages, it is capable of fulfilling several sets of objectives, with the mosaic of forests on a landscape fulfilling overall regional and provincial objectives at any particular point in time. The same logic applies to protected areas; depending on what is being protected, the physical location could change over time and active management may be necessary to ensure protection.

Develop a provincial wood-supply strategy

A clear set of provincial-level objectives and an overall strategy for managing the forest resource lays the foundation for a sound wood-supply strategy. The province needs to establish what types of wood it wants to produce and where this wood is most efficiently grown, within the constraints of all other values being derived from the land base. Consistent with the overall forest management strategy, the wood supply strategy should be developed from a landowner perspective, with the goal of maximizing return on investment. Recommendations from outside speakers unanimously suggested, in light of our relatively slow, northern growth rates, that we focus on the production of high quality, solid wood products.

Developing a sound wood supply strategy requires, however, that certain fundamental inventory components be in place. Workshop participants discussed the need for the following at length:

- **Forest inventory**. Ontario needs a comprehensive provincial inventory to take stock of the volume and value of all forest products; what we have (volume and quality), what is growing, what we are harvesting, what we are losing. Without this, we cannot attempt to minimize and capture losses or focus our efforts where we will see the greatest return on investment.
- **Soils inventory**. Ontario must have its soils defined at a scale that will permit us to properly match species to sites and consistently predict what the growth rates of these species will be. Every silvicultural activity should begin with an assessment of soils information as it relates to desired outcomes.
- **Growth and yield models**. Accurate predictions are needed for a range of species, on our different soil types, under various management intensities. This is a tall order, but the province must commit to reviving existing PSP networks and establishing new ones, particularly in managed forests.
- **Areas where timber management may occur.** To a large extent, this is a filtering exercise that can be achieved using GIS whereby land uses not compatible with timber production and non-productive forest lands are removed from the potential timber management land base.

Given these needs, a combination of site productivity, distance to mills, and constraints imposed by non-timber objectives, will dictate the optimum mix of forest management and silvicultural intensities required to meet agreed-upon wood supply targets. Under the 1999 Forest Accord, the Ontario Forest Accord

Advisory Board (OFAAB) has the responsibility to recommend locations for IFM in the province. However, to arrive at this optimum mix of management intensities – to develop a sound wood supply strategy – this group will clearly need the information outlined above. In its absence, we may need to speculate about where management intensity may be increased, but we must ensure that efforts are underway to acquire the necessary data to address the above issues.

A well-developed wood supply strategy that nests within an overall forest management strategy should provide forest industry with the level of confidence and certainty necessary to invest in silviculture and more intensive forest management. One of the clear messages from the workshop was that companies would not invest in IFM unless they own the resulting trees or have some form of guarantee to their future harvest.

Develop integrated silvicultural strategies

Fibre supply is rapidly emerging as a limiting factor to forest industry growth in the medium term and is a strong incentive to move towards more intensive forestry practices that can produce more wood from less area in less time. Above, we mention establishing objectives and then aligning policies and procedures to ensure their practical achievement. If producing more wood from less area in less time becomes a management objective for some areas, then policies and guidelines must be aligned to reflect this goal. The OMNR needs to ensure that planning is underway to permit modification of silvicultural guides and ground rules to encompass density-regulated and managed stands.

Ultimately, however, we need a listing or suite of *best management practices* for the full matrix of species, site, and potential management intensities. While developing this list is obviously a long-term task, we currently have a large volume of collective knowledge and experience about what these best practices should be. Therefore, in the short term, we should identify a suite of silvicultural practices as the current science standard. A comprehensive checklist would enable foresters to identify practices currently conducted on their management units and the level at which they are operating relative to the standard. Reviews of new practices as well as practices in other regions and countries should be done more frequently, perhaps with Ontario hosting a regular forum for such exchange. Further, an organized, funded, and effective lobby group could promote appropriate IFM practices and identify inappropriate applications.

Develop a protection strategy

Having a provincial forest management strategy for sustaining a mix of forest products dictates an accompanying strong commitment to forest protection and a sound strategy for its implementation. A wood-supply strategy that is based on a complex mix of management intensities will, in itself, require a very different approach to protection from fire, insects, and disease than we have grown accustomed to in this province. Different levels of management intensity will reflect a range of investments and corresponding values to be protected. Protection of the wood supply will also have to be considered in concert with protection of the supply of other forest values, creating a rather complex protection problem. Mechanisms will be required to determine when and where intervention is economically feasible, environmentally sound, and socially acceptable.

Develop a monitoring strategy

The results of our silvicultural efforts are often not evident for 5 years or more, making the business of growing trees in Ontario a relatively slow process. Silvicultural effectiveness monitoring (SEM) is a crucial step in the adaptive management process and critical in advancing the effectiveness of our silvicultural practices (Figure 2). SEM can range from the simple documenting and follow-up of current operational practices or an operational trial, to data collection in a more complex PSP network designed to capture the results of a range of experimental treatments. For SEM efforts to be worthwhile, it is essential that partners establish a set of key elements for any SEM data: core variables (e.g., FEC/ELC, soils), minimum sample sizes, and spatial cataloguing (e.g., NRVIS), at a minimum.

Ultimately, all SEM products should feed into a single electronic database that can be queried by key characteristics such as species and site type. Over time, this would become our *strategic silvicultural database* and fuel the development of integrated silvicultural strategies and best management practices. SEM is also critical for measuring our progress towards the achievement of management objectives. Commitment to the development of the strategic silvicultural database must be unanimous (among federal, provincial, and private agencies involved in forest management) and continuous, through both good times and bad.

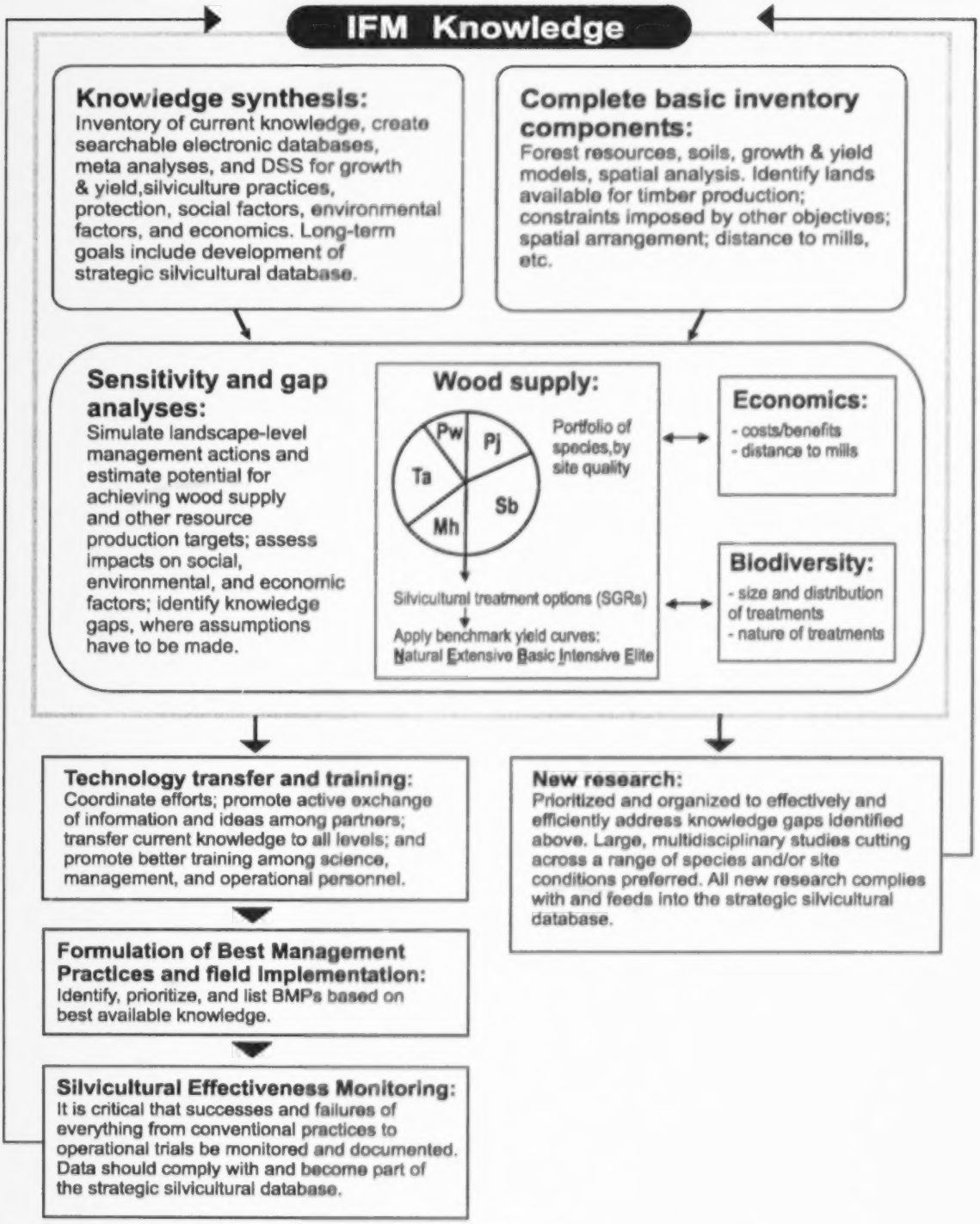
IFM Knowledge
Knowledge synthesis:
Inventory of current knowledge, create searchable electronic databases, meta analyses, and DSS for growth & yield,silviculture practices, protection, social factors, environmental factors, and economics. Long-term goals include development of strategic silvicultural database.
Complete basic inventory components:
Forest resources, soils, growth & yield models, spatial analysis. Identify lands available for timber production; constraints imposed by other objectives; spatial arrangement; distance to mills, etc.
Sensitivity and gap analyses:
Simulate landscape-level management actions and estimate potential for achieving wood supply and other resource production targets; assess impacts on social, environmental, and economic factors; identify knowledge gaps, where assumptions have to be made.
Wood supply:
Pw
Pj
Ta
Sb
Mh
Portfolio of species,by site quality
Silvicultural treatment options (SGRs)
Apply benchmark yield curves:
Natural Extensive Basic Intensive Elite
Economics:
- costs/benefits
- distance to mills
Biodiversity:
- size and distribution of treatments
- nature of treatments
Technology transfer and training:
Coordinate efforts; promote active exchange of information and ideas among partners; transfer current knowledge to all levels; and promote better training among science, management, and operational personnel.
New research:
Prioritized and organized to effectively and efficiently address knowledge gaps identified above. Large, multidisciplinary studies cutting across a range of species and/or site conditions preferred. All new research complies with and feeds into the strategic silvicultural database.
Formulation of Best Management Practices and field implementation:
Identify, prioritize, and list BMPs based on best available knowledge.
Silvicultural Effectiveness Monitoring:
It is critical that successes and failures of everything from conventional practices to operational trials be monitored and documented. Data should comply with and become part of the strategic silvicultural database.

Figure 3. Critical path for IFM science and information within an adaptive management framework.

Develop a science and information strategy

As suggested above, we have a large amount of knowledge and experience related to intensifying forest management. We should work towards implementing this knowledge, provided that results are monitored and used to fine-tune future practices through an effective SEM program. Science will be needed to guide us in the right direction during this fine-tuning and may, occasionally, point us in entirely new directions.

In outlining our recommendations for developing a science and information strategy, we will draw upon the concept of adaptive management, presented previously in the practices section, Figure 2, and expanded in Figure 3. This diagram summarizes what we feel are key steps in advancing our knowledge of IFM.

First, there are several critical tasks that must be completed before we can meaningfully initiate new IFM-related field studies. Collectively, these tasks focus on identifying exactly what we do and do not know. As a critical first step, we must "inventory" our existing knowledge and place it in a format that is easily accessed and searched by land managers, decision-makers, and researchers. Journal articles, technical reports, file reports, well-documented older field trials, etc., all contain knowledge and experiences that can serve as the foundation of our strategic silvicultural database. There is a large task at hand in simply gathering this information and compiling it into a searchable electronic database. In some cases, several data sets may exist on a related topic or practice (e.g., precommercial thinning), whereby meta-analysis of the combined data could yield new results or greater insights, adding to our knowledge. In even more sophisticated syntheses, the strategic silvicultural database could be combined with decision-support tools to construct expert systems or DSS. Crucial areas of focus for knowledge synthesis include growth and yield, silvicultural practices, protection, environmental impacts, social impacts, and economics.

Simultaneous to synthesizing existing knowledge, we must also address at least the basic inventory components discussed above (forest, soils, and spatial analysis). Not only are these needed to fully develop our wood-supply strategy, they will also help to direct our science activities. Essentially, we need to know where to focus our research efforts so that we (a) address true knowledge gaps, and (b) maximize returns on our research investments. Some of (a) and (b) will be addressed through the knowledge syntheses discussed above, with the remainder being revealed through model-based sensitivity analyses (simulation of various management options via our growth and yield models (SFMM)). To do these simulations, we need to know what lands are available for forest management (i.e., their spatial arrangement and distance to mills) and their productivity levels so that we can apply growth-rate projections for potential tree species, under possible management scenarios. Through these simulations, we can determine whether or not our wood-supply targets are realistic and identify where our knowledge gaps are with respect to growth and yield, economics, biodiversity, social issues, protection, education, and training. In essence, any assumptions that need to be made when developing our wood supply strategy must be verified by some form of research, followed by SEM, and adaptive management.

Once the knowledge syntheses and sensitivity analyses have been completed, we can then set priorities for future research and development efforts and establish work plans. We speculate that it will take a research partnership, consisting of forest industry and both the federal and provincial government, approximately 3 years to reach this point. All new research initiatives would generate data complying with and feeding into the strategic silvicultural database. We also recommend that priority be given, wherever possible, to larger multidisciplinary studies backed by a solid research team, since these types of studies have tended to be more cost-effective and synergistic in generating long-term, multivariate, multidimensional data than smaller single-problem studies. Also, as much as feasible, new studies should apply a common suite of treatments across different species and site types.

A very important component of the science and information strategy is rapid and effective transfer of new and existing knowledge to field personnel. Greater investment is required in this area, across a range of functions, from establishing common computer interfaces for electronic databases, to organizing and hosting annual workshops aimed at updating knowledge, redirecting priorities, and developing new work plans. We also need to place higher value and emphasis on training at all levels, from operators to managers.

Finally, the adaptive management cycle is the glue that binds the components of our recommended science and information strategy and is the essence of how we will better our practices and move towards achieving our goals. It is important that we actively promote information exchange among partners at all levels and meet to periodically review outputs from SEM and SFMM simulations, verify the achievement of objectives, redirect priorities, and develop new work plans.

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Appendix I. Intensive Forest Management Science Workshop Participants

Name	Affiliation	Location	Group*	Role
Alf Aleksa	MNR - FMB	Sault Ste. Marie	SC 1	
Paul Allaire	MNR district	Hearst	NE 1	
Dave Anderson	MNR district	Kenora	NW 1	
David Archibald	Bowater	Thunder Bay	NW 1	Speaker
Don Armitt	MNR district	Ignace	NW 1	
Jim Baker	MNR - FMB	Peterborough	NW 1	
Ken Baldwin	CFS	Sault Ste. Marie	NW 1	
David Baldwin	MNR - OFRI	Sault Ste. Marie		Speaker
Dave Barker	MNR district	Nipigon	NW 1	
Brian Batchelor	MNR - SCSS	North Bay	SC 1	Facilitator
Don Bazeley	Weyerhaeuser	Chapleau	NE 6	
Garnet Beemer	MNR district	Nipigon	NW 2	
Wayne Bell	MNR - OFRI	Sault Ste. Marie		Cochair
Rob Booth	Domtar	Red Rock	NW 1	
Blake Brunsdon	J.D. Irving	New Brunswick	NW 1	Speaker
Tom Bryson	Westwind	Parry Sound	SC 1	
Pat Burrough	MNR district	Hearst	NE 2	
Lisa Buse	MNR - OFRI	Sault Ste. Marie	SC 2	Facilitator (D2)
Errol Caldwell	CFS	Sault Ste. Marie	SC 1	
Al Cameron	CFS	Sault Ste. Marie	NW 2	Facilitator
Bob Campbell	CFS	Sault Ste. Marie	NE 1	
Brian Campbell	Domtar	Red Rock	NW 2	
Bob Carman	GPC Canada	Toronto		Speaker
Charlotte Caron	Abitibi Consolidated	Kenora	NW 2	
Rod Carrow	Consultant	Toronto		Speaker
John Cary	Living Legacy Trust	Toronto	SC 1	
Han Chen	MNR - NEST	South Porcupine	NE 1	
Marilyn Cherry	MNR - OFRI	Sault Ste. Marie	SC 1	
Samantha Chung	MNR district	Cochrane	NE 1	
Joe Churcher	MNR - FMB	Sault Ste. Marie	SC 2	Facilitator (D1)
Al Corlett	MNR - SCSS	Bracebridge	SC 1	
Chris Coulter	Environics	Toronto		Speaker
Tom Croswell	Spruce Falls	Kapuskasing	NE 1	
Qinglai Dang	Lakehead University	Thunder Bay	NW 2	
Rob Davis	MNR - FMB	Peterborough	NE 1	
Mike Dawe	MNR district	Kenora	NW 2	
Peter DeGroot	CFS	Sault Ste. Marie	SC 5	
Bob Deslauriers	Abitibi Consolidated	Fort Frances	NW 3	
Dave Deugo	MNR district	Parry Sound	SC 1	
David DeYoe	MNR - OFRI	Sault Ste. Marie		
Bob Dick	New Brunswick DNR	New Brunswick	NE 1	Speaker
Adele Dobkowski	Living Legacy Trust	Toronto	NW 3	
Steve Dominy	CFS	Sault Ste. Marie	NE 1	Facilitator
Phil Dougherty	Westvaco	South Carolina	SC 4	Speaker

Name	Affiliation	Location	Group*	Role
Dan Drennan	MNR district	Chapleau	NE 1	
Marc Dube	St. Mary's Paper	Sault Ste. Marie	SC 1	
Jim Duncan	MNR - FMB	South Porcupine	NE 2	Facilitator
Fraser Dunn	MNR - LUPB	Sault Ste. Marie	NW 2	
Brad Ekstrom	Hearst Forest Mgmt	Hearst	NE 1	
Ken Elliott	MNR - SCSS	London	SC 2	
Bob Elliott	Weyerhaueser	Sault Ste. Marie	SC 2	
Lara Ellis	Wildlands League	Toronto	SC 2	
Paul Fantin	Temiskaming For. All	Englehart	NW 3	
Don Farintosh	MNR district	North Bay	SC 2	
Rob Fleming	CFS	Sault Ste. Marie	NE 1	
Keith Fletcher	Algonquin Forestry Auth.	Huntsville	SC 2	
Randy Ford	MNR district	Swastika	NE 2	
Eileen Forestell	EDC-SSM	Sault Ste. Marie	SC 4	Facilitator
Michael Forrest	Domtar	Red Rock	NW 3	
Parthena Fotiadis	Domtar	White River	NW 4	
Brian Fox	MNR - FMB	Timmins	NE 2	
Dick Fry	Buchanan	Manitouwadge	NW 3	
Peter Gagnon	MNR - FMB	Sault Ste. Marie	NW 3	Facilitator
Clint Giesbrecht	Abitibi	Kenora	NW 3	
Paul Glassford	MNR - LUPB	Sault Ste. Marie	SC 3	
Nick Gooderham	Domtar	Timmins	NE 6	
George Graham	Hearst Forest Mgmt	Hearst	NE 2	
Chris Grant	Domtar	White River	NW 5	
Laune Gravellines	MNR - FMB	Sault Ste. Marie	NE 6	Speaker
Tim Gray	Wildlands League	Toronto	SC 3	Speaker
Rich Greenwood	MNR - FMB	Sault Ste. Marie	NW 1	
Sylvia Greifenhagen	MNR - OFRI	Sault Ste. Marie	NW 3	
Art Groot	CFS	Sault Ste. Marie	NE 2	
Rick Groves	Tembec	Timmins	NE 4	
Allan Gustafson	Whitesands First Nations	Armstrong	NW 5	
Matts Hagner	Swedish University	Sweden	NW 3	Speaker
Mark Hall	Tembec	Timmins	NE 2	
Jack Harrison	Dryden Forest Mgmt	Dryden	NW 4	
Blair Helson	CFS	Sault Ste. Marie	SC 3	
Joerg Hettman	Weyerhaueser	Wawa	SC 3	
Gary Hogan	CFS	Sault Ste. Marie	SC 3	
Paul Holman	Timberjack	Woodstock	NE 2	
Steve Holmes	CFS	Sault Ste. Marie	SC 4	
Paul Hosick	MNR district	Atikkokan	NW 4	
Nancy Houle	MNR - FMB	Timmins	NE 2	
Craig Howard	Bioforest Technologies	Sault Ste. Marie	SC 5	
Mike Irvine	MNR - FMB	Sault Ste. Marie		
Trevor Isherwood	Clergue Forest Mgmt	Sault Ste. Marie	SC 2	

Name	Affiliation	Location	Group*	Role
John Iverson	Domtar	Cornwall	SC 2	
Robert Jackman	Tembec	Timmins	NE 3	
Art Jacko	M'tiwa-Ki	Birch Island	NE 2	
Larry Jardine	Westwind	Parry Sound	SC 3	
Paul Jewiss	Abitibi	Fort Frances	NW 4	
Faye Johnson	Grant	Englehart	NE 4	
Joe Johnson	MNR district	Parry Sound	SC 2	
Derek Johnson	MNR district	Kenora		
Scott Jones	MNR - TAU	Sault Ste. Marie	NE 3	Facilitator
Dennis Joyce	MNR - FMB	Sault Ste. Marie	NE 5	
Mike Keenan	MNR district	Kenora	NW 3	
Darryl Kelly	Weyerhaeuser	Chapleau	NE 4	
Gord King	MNR - FMB	Timmins	NE 2	
Bob Klapprat	MNR district	Thunder Bay	NW 4	
Ed Kondo	CFS	Sault Ste. Marie	NE 3	
Paul Krabbe	Tembec	Temiskaming	NE 3	
Dave Kreutzweiser	CFS	Sault Ste. Marie	SC 5	
Janet Lane	Weyerhaeuser	Dryden	NW 3	
Jeff Leach	Spruce Falls	Kapuskasing	NE 3	
Ken Lennon	Kimberly Clark	Longlac	NW 2	
Sylvain Levesque	Grant	Englehart	NE 3	
Harri Liljalehto	MNR - FMB	Peterborough	SC 5	
Martin Litchfield	Domtar	Espanola		
Greg Lucking	MNR - FMB	Timmins	NE 3	
Blake MacDonald	MNR - OFRI	Sault Ste. Marie	NE 3	
Jim MacKenzie	MNR - NWR	Thunder Bay	NW 4	Facilitator
Tom MacLean	Domtar	Timmins	NE 3	
David MacLean	Univ. New Brunswick	New Brunswick		Speaker
Bruce MacLock	Sustain. For. Mgmt.	Alberta	NW 3	
Doug Maki	Vermilion For. Mgmt	Sudbury	SC 3	
Joe Maure	MNR - FMB	Sault Ste. Marie	NE 3	
Rob McAlpine	MNR - AFFMB	Sault Ste. Marie	NW 4	
Chris McDonell	Tembec	Callendar	SC 3	
Thom McDonough	MNR - FMB	Sault Ste. Marie	SC 7	Facilitator
Dan McKenney	CFS	Sault Ste. Marie	NE 4	
Craig McManus	Domtar	Cornwall	SC 4	Speaker
Richard McNaughton	CFS	Sault Ste. Marie	NW 4	
Bill Meades	CFS	Sault Ste. Marie	SC 6	
Phillip Meek	FERIC - East	Quebec	NE 4	Speaker
Tim Meyer	MNR - OFRI	Sault Ste. Marie	NE 4	
Diane Miller	Boreal Coop	Thunder Bay	NW 2	
Andree Morneault	MNR - SCSS	North Bay	SC 1	
Dave Morris	MNR - CNFER	Thunder Bay	NW 4	
Bernie Mueller	MNR - district	Sault Ste. Marie	SC 3	

Name	Affiliation	Location	Group*	Role
Geoff Munro	MNR - SDTB	Sault Ste. Marie	SC 4	
Steve Munro	Westwind	Parry Sound	SC 4	
Wayne Nakamura	MNR - FMB	Sault Ste. Marie	NE 4	
David Neave	Wildlife Habitat Can.	Ottawa	NW 1	Speaker
Corinne Nelson	MNR - FMB	Sault Ste. Marie	NW 3	
Peter Newton	CFS	Sault Ste. Marie	NE 6	
Brian Nicks	Domtar	Espanola	SC 5	
Cathy Nielsen	MNR - SCSS	Kemptville	SC 5	
Erin Nixon	MNR district	Sault Ste. Marie	SC 7	
Glen Niznowski	Buchanan	Sioux Lookout	NW 5	
Guy Noel	Tembec	Timmins	NE 4	
Tom Noland	MNR - OFRI	Sault Ste. Marie	SC 7	
Abby Obenchain	MNR - OFRI	Sault Ste. Marie	SC 3	Facilitator
Robert Paquette	MNR district	Kemptville	SC 4	
Trevor Park	MNR district	Red Lake	NW 3	
Bill Parker	MNR - OFRI	Sault Ste. Marie	SC 5	
John Parton	MNR - NEST	Timmins	NE 4	
Lisa Pauloff	MNR - FMB	Sault Ste. Marie	NE 6	
Nick Payne	CFS	Sault Ste. Marie	NW 4	
Marshall Pecore	Menominee	Wisconsin	SC 5	Speaker
Kelly Pike	MNR district	Kirkland Lake	NE 4	
Fred Pinto	MNR - SCSS	North Bay	SC 6	
Doug Pitt	CFS	Sault Ste. Marie		Cochair
Paul Poschmann	Abitibi	Thunder Bay	NW 5	
Dan Puddister	MNR - FMB	Sault Ste. Marie	NE 4	Facilitator
Derek Rice	Wildlands League	Toronto	SC 6	
Bill Roll	Bowater	Thunder Bay	NW 5	
Bill Rose	MNR - FMB	Peterborough	SC 6	
Keith Sayers	Mississauga First Nations	Blind River	SC 7	
Taylor Scarr	MNR - FMB	Sault Ste. Marie	SC 7	
Vivienne Scott	MNR - OFRI	Sault Ste. Marie	NE 5	Facilitator
Roy Sidders	MNR district	Red Lake	NW 5	
Larry Skinkle	MNR - FMB	Sault Ste. Marie		
Rod Smith	CFS	Sault Ste. Marie	NE 5	
Peggy Smith	Nat. Aboriginal For. Assoc.	Ottawa	NE 5	Speaker
David Smith	MNR - OFRI	Sault Ste. Marie	NE 5	
Guy Smith	CFS	Sault Ste. Marie	SC 5	Facilitator
Neil Stocker	MNR - FMB	Sault Ste. Marie	SC 6	Facilitator
MaryEllen Stoll	MNR - NEST	Timmins	NE 6	Facilitator
Bruce Strapp	EDC - SSM	Sault Ste. Marie	SC 5	
Peter Street	Vermilion For. Mgmt	Sudbury	SC 6	
Martin Streit	Domtar	Cornwall	SC 6	
Silvia Strobl	MNR - SCSS	Kemptville	SC 7	
Tom Terry	Weyerhaeuser	Washington	NW 5	Speaker

Name	Affiliation	Location	Group*	Role
Guylaine Thauvette	MNR district	North Bay	SC 6	
Dean Thompson	CFS	Sault Ste. Marie	SC 6	
Bill Thornton	MNR - FMB	Sault Ste. Marie	NE 5	Speaker
Clifford Tibishkogijig	Whitesands First Nations	Armstrong	NW 4	
Derrick Tirschman	MNR district	Manitouwadge	NE 5	
Bill Towill	MNR - NWST	Thunder Bay	NW 5	Speaker
Al Tremblay	Weyerhaeuser	Chapleau	NE 3	
Paul Tufford	Domtar	Elk Lake	NE 6	
Laird van Damme	KBM	Thunder Bay	NW 5	
Betty vanKerkhof	MNR - FMB	Sault Ste. Marie	NW 5	
Riet Verheggen	MNR - FMB	Sault Ste. Marie	NE 6	
Marinus Verwey	MNR district	North Bay	SC 7	
Ron Waito	MNR - NWST	Thunder Bay	NW 5	Facilitator
Peter Wall	MNR district	Hearst	NE 5	
Chris Walsh	MNR Region	Timmins	NE 5	
Bob Watt	MNR - NEST	Timmins	NE 5	Speaker
Ken Webb	Westwind	Parry Sound	SC 7	
Mike Weber	CFS	Sault Ste. Marie	NE 5	
Dave West	Bowater	Thunder Bay	NW 4	
Suzanne Wetzel	CFS	Sault Ste. Marie	NW 5	
Eric Whan	U of Toronto	Toronto	NE 6	
Ralph Wheeler	MNR - NWST	Thunder Bay	NW 1	Facilitator
Tim White	Timberjack	Woodstock	NE 6	Speaker
Tim Williams	MNR - SCSS	London	SC 3	
Eric Wilson	MNR - NRIB	Sault Ste. Marie	SC 7	
Dwight Scott Wolfe	McGregor Model Forest	British Columbia	NE 6	Speaker
Murray Woods	MNR - SCSS	North Bay	SC 4	
Ralph Young	Whitefish	Naughton	SC 1	

* Even though most participants were assigned to a breakout group, some chose not to participate in the discussions.

CFS - Canadian Forest Service
CNFER - Centre for Northern forest Ecosystem Research
DNR - Department of Natural Resources
EDC - Economic Development Corporation
FMB - Forest Management Branch
LUPB - Land Use Planning Branch
NEST - Northeast Science and Technology
NRIB - Natural Resources and Information Branch
NWST - Northwest Science and Technology
OFRI - Ontario Forest Research Institute
SCSS - South central Science Section
TAU - Terrestrial Assessment Unit

Appendix II. Level of silvicultural activity during various management eras in Ontario

Workshop Reference Level	Protected Against	Silvicultural Activities	Pre-1978 (Timber Production Policy)	1979 to 93 (Crown Timber Act)	1979 to 93 (Crown Timber Act)	Post-1999 (Ont. Living Legacy & Forest Accord)
0	Fire	**Unplanned natural regeneration** Selective harvest (high-grading)	"Cut and walk"	"Cut and walk"	Not considered	Not considered
1	Fire & insects	**Planned natural regeneration (vegetative/seed)** • Clearcut silviculture system • Shelterwood and selection silviculture systems without tree marking	Extensive	Extensive	Extensive	Extensive
2	Fire, insects & disease	**Assisted natural regeneration** • Modified clearcut silviculture systems (e.g. strip cutting, clearcut with seed trees) • Shelterwood and selection silviculture systems (without tree marking) and application of careful logging • Harvest and advanced regeneration protection (HARP) • Scarification for natural reproduction (vegetative/seed)	Basic	Basic	Extensive/ basic	Extensive/ basic
3	Fire, insects & disease	**Assisted natural regeneration and artificial regeneration** Includes Level 2 activities, in addition to 1 or more of: • shelterwood and selection silviculture systems, with tree marking, and application of careful logging • Scarification for natural regeneration and/or direct seeding • Site preparation and planting • Vegetation management - cleaning to achieve species composition objective in future forests	Intensive	Intensive	Basic	Basic

Workshop Reference Level	Protected Against	Silvicultural Activities	Pre-1978 (Timber Production Policy)	1979 to 93 (Crown Timber Act)	1979 to 93 (Crown Timber Act)	Post-1999 (Ont. Living Legacy & Forest Accord)
4	Fire, insects & disease	**Assisted natural regeneration and artificial regeneration, featuring density regulation at a young age** Includes Level 3 activities in addition to 1 or more of the following: • Site preparation and precision direct seeding or planting • Re-fill planting • Use of large nursery stock • Vegetation management - multiple cleanings to achieve species composition in future forest condition and timed to maintain rapid stand growth • Polewood thinning to select individual crop trees • Pre-commercial/juvenile spacing to achieve species composition in future forest condition and maintain rapid stand growth • Stand improvement cuts to promote quality • Overlapping rotations using shelterwoods for hardwoods and conifers	Not considered	Elite	Intensive	Intensive
5	Fire, insects & disease; possibly browsing (e.g., tree shelters) in tolerant hardwood regen.	**Assisted natural regeneration and artificial regeneration, with strict density regulation and/ or genetic improvement** Includes Level 4 activities in addition to 1 or more of the following: • Prime land/site management • Crop planning • Scarification and direct seeding with genetically improved seed • Commercial thinning • Pruning	Not considered	Not considered	Elite	Intensive/ elite
6	Fire, insects & disease; possibly browsing (e.g., tree shelters) in tolerant hardwood regen.	**Assisted natural regeneration and artificial regeneration, strict density regulation, genetic improvement, including site amelioration and/or genetically altered stock or seed** Includes Level 5 activities, in addition to 1 or more of the following: • Fertilization • Drainage or irrigation • Artificial regeneration with strict density regulation - planting of genetically altered clonal stock (e.g., Roundup-ready aspen) • Multiple prunings of individual crop trees	Not considered	Not considered	Not considered	Elite

Appendices III - VII present raw results of the facilitated session discussions synthesized from flip chart notes. Numbers and letters in brackets refer to region and group number and can be linked back to participants using Appendix I. Some effort was made to organize and consolidate the information, but for the most part the words remain those of the participants.

Appendix III. Practices

Concern	Comments
Even- versus uneven-age management	• Even vs. uneven-age management which produces a greater volume of quality wood? (SC G4) • Develop and test new silvicultural systems for boreal mixedwoods (NW G2); test selective/shelterwood for management in mixedwoods and black spruce (NW G3) • Uneven-aged silviculture information – upland and lowland black spruce (NE G1) • Presently clearcut; merchantable spp (NW G2); managing 2-tier stands i.e. poplar overstory with white spruce understory (understory not defined as advanced regeneration) (NE G4)
Even-age management - Clearcutting	• Natural versus artificial regeneration (SC G1) • Issues - structural legacy, blowdown issues, genetic implications (SC G1) • Where does it not work and why should we do it there? How many seed trees should we leave? How should they be distributed ? • Silvicultural systems for tamarack (NE G1) – clump or scattered? (SC G1) • Investigate improved use and need for residuals in clearcut system (SC G2)
Uneven-age management – Shelterwood	• Shelterwood regeneration systems (NE G4); investigate modifications to system (SC G2); need new tools, equipment for shelterwood (SC G1); modifications by site and region/range; (e.g. old, isolated stands) (SC G1); natural versus planted regeneration (SC G1); crown spacing (SC G1); cutting cycle (SC G1); pre-harvest versus post-harvest prescribed burn (SC G1) • Impacts of shelterwood - Impact of logging damage on growth and yield, cutting cycle length, quality of products, effect on forest health (SC G1); Genetic implications: viable breeding population; pollen flow (SC G1); determine insect response and identify extent of logging damage on advanced regeneration (SC G7) • How to manage winter logged, poorly accessed areas (SIP (new/different equipment need), tending) (SC G1) • How shelterwood can be used for conversion of hardwoods to conifer, poor hardwood to good hardwoods (SC G1) • Can it be tested on hard maple to meet ecological purposes – landscape objectives – use of shelterwood on a landscape level (SC G1) • Conifer & hardwood – need more work around group shelterwood, strip shelterwood.... definition and application (SC G1) • Monitoring of wildlife that ties into multi-scale modelling (NE G4); need more wildlife population viability modelling tied to FRI-type data and life history data/information (NE G4); need sound scientific data to set parameters of models and species/habitat requirements (SC G4); need habitat models for species requirements (NW G5) • Adapt existing decision-support system tools to IFM practices; use monitoring with adaptive management (NE G1) • Wildlife: Prove it (Watt's talk) - minimize use of precautionary principle (NE G4) • Endangered species management (SC G7); need inventory on endangered species – where are they and what are they (SC G7); habitat requirements of endangered species (SC G7); monitoring sensitive species (SC G5,7); Need relationship of rare, threatened, and endangered species/stands to sites with potential to be managed under IFM (NW G5)

Concern	Comments
Uneven-age management - Selection	• Applicability of Swedish research in selection harvest and thinning activities to Ontario; selection harvest - consider all forest types in boreal (NW G3) • Refinement of stand structure - J curves, calibrate to site (SC G1); tolerant hardwood -- multiple Q values; stand structure targets are required for different sites/based on site quality or productivity (SC G1) • Develop models for group selection systems (SC G2) • Superimposing group selection on single-tree selection - including group selection; how much should you do?; mid-tolerants within tolerant hardwood; where do they go? (SC G1) • Where should it be applied, e.g. maple sites on north shore (SC G1) • Determine best areas in region to apply single tree selection to realize greatest gains in quantity and quality sawlogs (SC G7) • Genetic implications of single-tree selection (SC G1) • Investigate modifications of selection (group vs. single tree methods) (SC G2) • Raise knowledge base of forest practitioners on alternative silviculture (silvics); group selection...on Cb, Or, Aw, Bd (SC G7) • Test group selection silviculture for effectiveness for regenerating high value timber species that are less shade tolerant than maple and beech (SC G7) • Need research on "group selection" as a practice (compared to single-tree selection) (SC G7) • Need more treatment response data for group selection and shelterwood - Ontario data - how many, how much to feed models - effects on wood volume and quality (SC G2) • Need to question all-aged/selection system management system - status quo may not be the best way to manage southern Ontario hardwoods (SC G5)
Harvesting	• Improved utilization technology e.g.; chipping small diameter stems (NW G4) • Improved database linking wood harvested to location of harvest (NW G5); Use GPS on feller buncher (NW G5); Point of harvest - Training/education of operators (NE G5) • Pre- and post harvest timber cruising (NW G5); preharvest inventory (NE G5); assessment of stand condition (NE G4) • Partial harvest: windthrow probability; volume response; regeneration potential; quality, where (sites) can it be done; prescription to use by site to address windthrow, potential future regeneration, etc (NW G5); Information on partial harvesting - removing aspen from mixed stands (NE G1) • Increased partial cutting in mixedwood stands (NE G3); Develop or report on logging techniques (harvest system) for 2 possible logging or partial stocking removal of multiple and stand - or stand with trees at differing levels of development (NE G2) • Careful logging - site damage, residual damage, link equipment to site condition (NE G3); Study CLAAG in NW condition (NW G5) • Harvest options in riparian zones (NW G2, NE G1); Selective harvest in reserves/ riparian harvest (NW G2) • Impact of logging damage on growth and yield, cutting cycle length, quality of products, indeed, on forest health (SC G1); Logging damage in hardwoods using shelterwood (SC G1) • Effects of removing hardwood first in mixedwoods (residual damage, blowdown - identifying sites where least damage will occur) (NE G5) • Harvesting systems and silviculture need to be integrated drastically! (NW G3); Link harvest method/silviculture on quality of future crop (NE G3) • Long-term spatial harvest model (NE G3) • Successional pathways and species shifts after partial cutting (NE G3); Successional pathways under no harvest conditions (NE G3)

Concern	Comments
Site preparation	
Site preparation - Prescribed fire (Pb)	• Pbs (Tool that is not used now; potential for more innovative use of fire; Fire strategy; Priority sites; Cost is very high; Not an operational tool right now) (NE G3) • Encourage more use of Pb in IFM (NW G1); make Pbs a more accessible tool - use in more stand types/ emulate natural disturbance (NW G2); Use of Pbs - less now - problem (NW G5) • Promote Pbs in appropriate forest types (SC G4); Pb - establishment of plantations on mixedwood sites (NW G2); Response of black spruce to site preparation/Pb (NE G1) • Increased use of Pb and planting of larger stock - best bang (NE G4) • Pre-harvest site prep with Pbs (SC G6); Investigate use of Pbs in multi-stored stands (SC-G2) • White pine and red pine on crown lands - preharvest burns for natural regeneration (SC G3) • Science best bets - response to Pbs (SC G6) • Pbs (conditions for burning, need to identify conditions with more accuracy so that burn has better chance of going ahead and will be more economical; alternatives to burns that don't take place, i.e. chemicals) (SC G6)
Site preparation - Prescribed fire – barriers to use	• Improve flexibility of Pb guidelines to make it more economically feasible to do more pbs to regenerate high value species like oaks (on appropriate sites) (SC G7); Pb policy - too restrictive, leads to high expense, leads to lack of use, leads to decreased diversity of mid-tolerants (SC G7); barriers to use of Pbs in southern Ontario (SC G5) • Conditions for burn and when you can't burn; policy makes it too expensive (SC G6)
Site preparation - Mechanical	• Assess new SIP equipment as it comes along (NW G5) • Training packages/sessions for operators on environmentally sensitive SIP on heavy soils (NW G1) • Current IFM Practices - site preparation chemical/mechanical - basic or IFM (SC G6)
Regeneration (general)	• Mixedwood renewal strategies (NW G4) • Mixed species renewal in a mixedwood condition (NW G5) • Underplanting in mixedwood in understocked stands (or stands without understory) (NE G3) • Stand reclamation, i.e. budworm-killed stands, high productivity of black spruce but tough to regenerate (NE G1) • Regeneration potential of tamarack (NE G1) • Regeneration - Ash, cherry, white pine, basswood, red spruce, red oak, hemlock, yellow birch, cedar; mainly where site is occupied by off-site hardwoods (SC G1)

Concern	Comments
Regeneration - Matching species to site	• Matching species/site. Do it on the right species! (SC G3); tree species/site combo will be important consideration - poorer sites may have a species that will do if we make the right choice, so pre pick species to site matches based on silviculture program (NE G2); choosing the most appropriate site to bring a species back (SC G1), correctly match species to site/soil (SC G2), planting stock to correct site type -> maximizes production (NW G3); putting the right species on a site to maximize growth (SC G4); get best species on right site prescription and get that species to grow to the best quality and value (SC G1) • Develop "research database" of treatment response by species, site; species versus site matrix of best bets for IFM (SC G2); plot best-bet practices on matrix of species versus site (SC G5) • Species trials - matching best species to the site (NE G1); growth & yield information by site, species & Rx (SC G2); diagnosis and nutritional need, of a stand (Pw, Pr, hwds) (SC G4); identify limiting factors controlling red pine - white pine growth rates across the existing range of soil site groups (SC G4); more information on growing different spp. (local) (SC G6) • Basic ecophysiological mechanisms & application in silviculture practices and Rx's (limiting factor) (NW G2); Determine "limiting" factors to seedling performance (NW 5); micro site planting (NW G4); species/site habitat (SC G4); what is best species to plant on the various soil, aspect, elevation, condition with and without intensive forest management? (SC G4) • On sites suitable for IFM and for the 2-3 best species what are the silviculture needs to optimize the growth of these species on the identified soil sites (SC G4)
Regeneration - Natural	• Ingress of naturals (NW G4); natural regeneration - what will be the result? (NE G5); more work to ID relationship between sites and ingress of naturals where, by when, how much (NW G5) • Evaluate current natural regeneration practices (NE G4) • Regenerate stand using natural process or at least using seed from area harvested to artificially regenerate (SC G7)
Regeneration - Artifical	• Current IFM practices - Artificial regeneration for species/stand conversion (SC G6) • Planting correct stock types ->root structure (NW G3); plant large stock (NW G2); stock type to site and site preparation (NW G2); investigate nursery silviculture interactions to identify site, species, stock-type specific site treatments (NW G2); look at planting without SIP, right after cut (NW G3); plantations - stock quality (SC G1); seedling quality assessment stock type trials (NW G4); white pine - underplant with best stock; best planting stock grower regime (SC G2) • Nursery cultural practices (additional gains still possible) (NE G3); information on nursery cultural practices for tamarack (NE G1); more stock options for reforestation (clonal cuttings) (SC G6); assess new types of planting stock as they come along (NW G5) • Use of appropriate seed source (seed zones) (NE G3); mycorrhizae innoculation - long term (NE G4) • Emphasize total site occupancy (NW G3); refill/in-fill planting (NE G5); white pine and red pine on crown lands - Infill plant if necessary (SC G3); regeneration survey- analyze site occupancy (NW G3) • Mixed species planting (NE G5); mixed planting i.e. black spruce and white spruce, jack pine and black spruce (NE G3) • Training of planters to recognize sites (NE G5)

Concern	Comments
Regeneration - Guidelines	• Need survival probability curves for seedlings of high value species (red oak, yellow birch, black cherry) to reduce tending costs - how many do you really need to establish - feeds into regeneration standards guidelines (SC G2) • Revise planting guidelines (initial stocking) to reduce need for costly thinnings (SC G4)
Tree Improvement	• Tree improvement R & D - continue with (NW G5, SC G7); tree improvement (NW G2, NW G3, SC G5); improved genetic stock (NW G1); plantations - genetically improved stock (SC G1); white pine - planting - best genetic stock for quality: knots; resistance to defect (SC G2) • Develop breeding strategy (NW G1); tree improvement opportunities for black spruce (NE G1), expand tree improvement to white spruce and white pine, red pine (NE G3); wide genetic base required to promote improvement (SC G7) • Cone collection seed zones directed collection (SC G6); red pine seed sources and applicability of seed zones (SC G1) • Revisit current & established tree improvement program (what worked, what didn't) (NW G1); collect data from 1st generation orchards where not available (NW G1); analyze all available 1st generation data (NW G1) • Survey of current seed orchards and possible use (need culling, etc.) status report (SC G7); can we use seed orchards already put in? status after years of neglect; need to determine the value of the existing orchards so that seed can be used (SC G6); reestablish seed orchards, SPA's (NE G5); how to rogue orchards (NE G5) • Genetic improvement of trees - need information on the management of seed orchards to increase seed production (SC G7); use operational seed orchards for more seed production by management enhancements (fertilize, water, further rogueing if needed) (SC G7) • Genetically improved stock (NW G2); realized gain trials (NW G2); establish gains trials (NW G1); realized gain trials for tree improvement; Pj, Sb genetic gain (SC G2) • Disease and insect resistant white pine and white spruce (SC G6); use of better resistant (disease/insect) species or clones (SC G7); insect/disease resistant tolerant hardwood (beech, maple, oak, elm, butternut, black cherry) (SC G6) • Gaps."Reliable knowledge" gap to move from 1st to 2nd generation (Science and information gap) (NW G1); Establish 2nd generation seed orchards (NW G1); cross-pollination and/or biotech to establish 2nd gen. orchards (NW G1); tree improvement with SB moved to 2nd generation (NW G3); need impacts of F2/clonal material on population genetics (NW G5); best bet: 2nd generation seed orchard (tree improvement) Sb, Pj, (Sw)?, (Pw)? (NW G1) • Clonal forestry??? (NE G4); clonal planting of hardwoods for veneer quality and logs (NE G3); aspen clonal research - utilizing superior clones (NW G2) • Determine effects of tree improvement and appropriateness (NE G6); tree improvement as a general rule (NE G4); genetic diversity (SC G6); genetic effects (variability reduction) who pays? (SC G6); link to update genetic conservation policy (NW G1) • Exotics (NE G5); assessment of hazard potential from exotics to the ecosystem (NE G4) • Different BTN improved and genetically modified needs to be explained (NE G5); genetic manipulation - how much is acceptable? (NE G1); genetically modified stock (insect/disease resistance, political issue, will occur on private land, need to understand and communicate to public) (NE G5) • Take advantage of new technology (NW G1); develop appropriate equipment and operator training to effectively and efficiently implement harvesting of genetically improved seed (NW G1)

Concern	Comments
Stand improvement	• Best bets for IFM - stand improvement cuts - all-aged systems (SC G6); improvement cutting (SC G3); through girdling, subsidies, improving markets, requiring operators to remove it (SC G5); investigate use of single-tree herbicide applications (SC G2) • IFM practices (SC G7); low grade hardwood stand with predominantly maple regeneration (SC G7); hardwood improvement cut - too many poor hardwood stands (may need to cut heavy and start over!) (SC G7); stand improvement practices - mixedwood sites with mostly intolerant hardwoods (SC G7) • Training/workshops for stand improvement cuts through girdling, tree-marking, etc. (especially on private land) (SC G2); training (SC G5)
Vegetation management	• Best bets for IFM -tending juvenile stands at the right time (SC G6); criteria thresholds -> timing herbicides (NW G5); intensity and selective effect of different herbicides on different species (SC G1); Will successive sprays free up enough nutrients to mimic fertilization? (NE G1); cleaning/vegetation management (multiple treatments) (SC G6) • Vegetation management (NE G4, NW G3); stand tending - other than jack pine (NE G4); age of white pine required for Vision resistance (SC G1); effective (selective?) control of balsam fir - need more knowledge (SC G3); • Viability of plantation cleaning when intra-specific competition present (VMAP) (Ingress) (NW G2); cleaning (NW G3) • Aerial herbicides (simultaneous application of different herbicides; requires changes to legislation) (NW G2) • Improved technology in the application of herbicide; more efficient application techniques (NE G3); develop appropriate equipment and operator training io effectively implement ground spraying of herbicides (NW G1); silvicultural equipment technology - vegetation management alternatives - FERIC (SC G4) • Ability to apply mixed registered herbicides like in U.S. (NW G2); Vision versus triclopyr (SC G1); information dissemination related to the use of "Release" (SC G6); tending of conifers using basal bark treatments (release) (SC G7) • Use of herbicides impact (NW G3); long-term impacts of vegetation management (NW G5) • Take steps to ensure that chemical vegetation control remains an available tool (SC G3) • Alternative vegetation management techniques (NE G1, SC G6); more VMAP work required (NW G5); non-chemical vegetation mgmt options VMAP -> suite of treatments including staged harvest (NW G4); manual release with herbicide (NW G2); bio controls (SC G6) • Synthesis for effectiveness of vegetation management in uniform shelterwood; effectiveness of vegetation management in uniform shelterwood system (SC G6); testing of aerial tending in uniform shelterwood (SC G6, G7); test aerial tending on uniform shelterwood pine areas (post seed-cut) (SC G7)

Concern	Comments
Density regulation	• Before understanding what can be done and what works- pre and commercial thinning etc. (NW G3); Understand natural thinning / stand improvement and incorporate where applicable (NW G3) • Science best bets - response to thinning (SC G6, NE G3), - 1st step - literature search (NE G3), Some info available (NE G5); Mid term results (NE G5); Silviculture techniques for quality forest products, e.g. spacing. (SC G2, SC G3); Density regulation - PCT and CT (NE G3, NE G4, NW G3); Existing forests - PCT, cleaning (SC G5), Managing existing forest with PCT, tree-marking (SC G2) • Determine effects of density mgt and appropriateness (NE G6); growth response(SC G4) • Response of GLSL tree species to PCT and CT - Impact on yield; Mixedwood, Mixed conifer, Pr - OK (NE G3) , Pw & Pr Crownlands - PCT (SC G3); Best Bets for IFM -PCT and 1st CT for Pw, Sw, tolerant hardwood at even-aged polewood stage (SC G6) • Response of boreal tree species to PCT and CT - needs a better understanding (NW G3); planting density/ spacing for Sb (NE G1); Sb, Pj, Sw - not recommended) (NE G3); PCT (Pj, Sb, Pb) and CT (Pj & Sb) (NW G1); Growth response of Sb to CT (NE G1); Can Sb be thinned successfully (NE G1); Thinning in over-stocked Sb stands (NE G3); Tamarack response to thinning and tending (NE G1); Aspen spacing (NW G2); mixedwood spacing - for sawlog and veneer production (NW G2); • PCT - where (NE G5); in mixedwood - viability?/when? (NW G2); naturals - where/when? (Regen) (NW G4); by timing / site / species / density spacing tending (NW G4); timing (SCG4); even-aged systems (SC G6) • Commercial thinning (NW G3, NE G5); remove exception from guides (NW G2); operation, equipment testing (NW G5); - studies / trials / demos to assess effectiveness in Ontario context (NW G5); development of a systematic approach to design silvicultural system (NW G3); $ criterion (- profit) (SC G6) • Intensive crop tree control (NE G3); Different density ranges (NW G5); Need site specific stocking / density standards (NW G5); determine appropriate timing of silvicultural intervention in stand development (NW G5, SC G3) • Develop variable density growth and yield functions for ALL species (SC G4); develop models for intermediate thinning (SC G2); Stocking guides for polewood, maple, etc. need to be calibrated for Ontario (SC G1) • Do you believe the density support tools are useful? If not, what should be done to make them? It is a useful tool for trees of equal size and because we have nothing else! (NW G3) • Density management diagrams (DMDs) - develop decision support systems at a stand level; assess optimum level of AGS/VGS (SC G2); DMDs (more info/training, better tech. Transfer, continuous improvement in info) (NW G2); Further research to substantiate DMDs (SC G6,G7); Complete for all species (NW G5, SC G7); Calibration for different site types (NE-G5, SC-G6, SC-G7); Ontario based (SC-G6, G7). • Develop equipment for commercial and precommercial thinning (NW-G1, G3, SC-G3, 4, 6, 7; Develop appropriate equipment and operator training to effectively and efficiently implement economical (i.e., less labour intensive) (NW G1); More spacing - develop better methods (SC G6); equipment to do all thinning (SC G7); that is appropriate to boreal and GLSL -- INVEST IN CANADIAN PRODUCTS (SC G3); Determine appropriate method of silvicultural intervention in stand development (SC G3). • Use of chemical to reduce PCT needs/cost - chemical site prep, directed chemicals years 1-5 - equipment needs (SC G4) Vision, e.g. rates for maple control (SC G1), Triclopyr - where and when for hardwoods (SC G1) • $ returns (SC G4); Production costs/thinning costs (NE G5); Continued market development for PCT and CT products - low grade materials - value added (biotech) (SC G4); Cost-benefit studies on PCT of different densities (NW G5); economic analysis of what stands (density, size), quality of residual trees is acceptable for PCT (SC G4); Reduce thinning costs - is chemical thinning an option? (SC G4) • Understanding relationship of PCT to wildlife habitat (NW G5) • Training packages/sessions for operators on thinning Sb/Pj from below (NW G1) • Tomorrow --- thinning for Pr - money, people. We know what to do but we often can't do it (SC G1)

Concern	Comments
Pruning	• Best Bets for IFM - pruning (SC G6); pruning (NW G3, NE G3) • Determine the effects of pruning on insect and disease suceptibility (SC G7) • Synthesis for pruning trial work when - when not - economics and effect (SC G6, 7). Pruning - more info needed (SC G6)
Fertilization	• Nutrient management (SC G5); Methods to improve/sustain soil productivity- effects of IFM on above (site impacts) (NW G2); fertilization (NW G3, G4); (early/late) intervention fertilization (NE G4); Nutrient management - Does nutrient management have a role/effect in Ontario? (SC G2) • Soil enhancement to improve nutrient availability to Sb (NE G1); fertilization has shown real potential for Pj, this could be important for sawmills during gap (NE G2) • Summarize results of past fertilization trials - some work already done by site/species - search (NE G3, SC G7); fertilization (value of fertilization, testing fertilization range of effects on growth & wood quality) (NW G2), What are the impacts?; results Canada-wide are poor - has to be mixed with CT and soil, windthrow, etc. as nutrients go into stem not roots (NE G6); potential effects of fertilization on tree response (no growth rather change in resistance to insects and disease) (SC G3); determine effects of fertilization - appropriateness and response (NE G6); long-term info on effects of fertilizer on yield (NE G5); G&Y plots for fertilization (NW G5), fertilization response of Sb, with and without tending (NE G1), information exists other jurisdictions (SC G7), Ontario extrapolation of information that exists in other jurisdictions? (SC G7) • Do some fertilization trials research! Determine best bets for success (NW G5) ; fertilization - have to do lab work to know how much and to calibrate (NE G6); determine limiting nutrient/factors on site basis (series of trials) (SC G7) • Fertilization as a substitute for herbicide use (NE G3) • Fertilization - are the costs/benefits there over long rotations? (NW G2) • Identify ecological impacts (SC G7); long-term info on effects of fertilizer on environment (NE G5), insect response (SC G7)
PAST AND FUTURE RESEARCH: Northwest Region	• Test range of scales (re. experiments) and test range of sites and opportunities (e.g., testing thinning on poor sites - biggest bang for the buck) (NW G3) • Plan - have one! (NW G3) • International peer review of experimental results (not only foresters) (NW G3) • Directing science activities in support of Ontario FMPM, EA & CFSA (NW G3) • Research direction: Focus on basic ecophysical mechanisms and their application in silvicultural practices and prescriptions particularly the mechanisms of tree's responses to silvicultural treatments (NW G2) • More research is required and it must be coordinated among agencies (NW G2)

Concern	Comments
PAST AND FUTURE RESEARCH: Northeast Region	• Conduct a literature of IFM practices, studies, trials, and operations reports in our and other jurisdictions. Show where these studies might be applicable in the various climate - geo physical zones of N.E. (NE G2) • Analysis of old trials (NE G1) • Examine (find - reestablish) old CPPA - Company plots to find results of their interventions to give some indication of results of practices in the short term. Cannot wait for results from new trials (NE G2) • As in #2, look at old silviculture projects and measure results to try to collect experiential info. Look for controls established with these projects to determine project impacts (NE G2) • Summary of IFM work by species - literature search (NE G3) • Compendium of IFM work and impact on other values - search (NE G3) • Need forest industry to DO and DRIVE effective research - quick turnaround (NE G4) • Need to integrate information (NE G4)
PAST AND FUTURE RESEARCH: South Central Region	• Beware doing science/research if knowledge is out there already - look at existing knowledge and early trials (SC G1) • 'Information needs' - imply need for gap/problem analysis that may reveal science needs (SC G1) • 'sliding scale': information needed/science needed • Improved information management (SC G6) • NEED - literature review (SC G1) • PRACTICES - ACTIONS? List science/info need by type (Research; Literature review; Policy; Tools; Demo. Areas; Workshops; Tech. Notes Staff/Operator Training (SC G3) • Lit. Review/Synthesis of past trials, practices (in Ont. and elsewhere) and results (traditional and non-traditional sources) (SC G2) • What has been done, is being done (here & elsewhere) (SC G5) • Identify information we need to collect (SC G5) • Education; investigate "forest banks", land mgmt. companies (SC G5) • Better information and more! - treatment results, effectiveness (SC G6) • Many prescriptions are based on best guesses right now. Do we really know? (SC G1) • Testing whole "range" of an application, local testing if required (SC G1) • May require more strict/less strict guidelines and standards (SC G2) • Guides/best practices to standards (SC G7)

Appendix IV. Growth and Yield

Long-term commitment to G&Y	• Long-term commitment to growth and yield (SC G4); G&Y (SC G2); G&Y is important (NW G2); G&Y is the report card for forest management (SC G4); • Develop G&Y model that will be applied to project growth and yield for a range of silviculture treatments. Species by site, stocking levels, timing of thinning (PCT), assess impacts of disease, insects, fire; benefits of site preparation, weed control, fertilization across a range of sites (NW G5); • Ensure G&Y program includes: managed stands, natural, overmature, unmanaged stands; need high confidence in info about older age classes; and uneven age curves (NW-G5); while we have some "average yield curves" we must expand our yield curve database to cover a full range of treatments and forest types and ecosites (NW G1) • G&Y modelling and yield curves (NE G5); forest modelling (SC G4), managed stand yield curves (NW G1); yield curves (vol & quality intensive!) (NW G2); develop stand-level models to support decision making at stand level - aggregate to wood supply (SC G4); stand dynamics side – G&Y (NW G5) • Local calibration (NE G3); make FMU specific (NW G5); stand dynamics/rotation length of black spruce (NE G1); refine/Improve mgmt mid-tolerants to understand economics (SC G2); more science on boreal mixedwood G&Y (NW G2) • Improved data re yield (NW G1); stand level G&Y data (NW G1); better growth and yield data – any type of stands (NE G3); lack of empirical stand level growth & yield data by treatment (NW G1); long-term PSPs and data syntheses of existing PSP (NW G2) • Expectation vs. actual G&Y (SC G2); assess the impact on forest growth & yield (NW G3); discover what truly limiting factors are (NW G5) • Better understanding of successional pathway of managed stands (NW G5); stand response to renewal treatments – successional pathways (NE G1)
Link G&Y to sub-regions and site types	• Growth & Yield by sub-region – most of existing info. is Algonquin Park. Need info. in transition areas! e.g. north of SSM (SC G3); Gap: lack of spatially mapped ecosites (partially completed); treatment effects;mapped (GIS) ecosites (NW G1) • Modelling response to treatments, short term, long term – strategic direction (NE G5); long-term soil productivity and harvest method / season yields / recovery (NW G2) • Site productivity classification, site index information (NE G4); Site specific G&Y information (SC G4); Growth/yield – *key – doesn't yet capture range of sites (SC G3)*; Site productivity of the variety of species (Review current literature) (NE G1); understand G & Y responses x all sites to feed into CB models (NW G5); site classifications to maximize productivity (SC G4); determine the potential growth rate of the species suited for this zone if resource supplies are optimized (SC G4); need species correlation curves linked to various site types (G&Y) of established stands [expand G & Y program] (NW G5); Improved equations by site type (NW G5); volume tables and site tables require updates? (SC G7) • Improve understanding of stand-level productivity information by treatment, site and species (NW G1); Sustainability with respect to long-term productivity; Understanding nutrient cycling (NW G1) • R & D to quantify treatment effects at stand level; Implement photo interp. methods to map using existing FECs; Include ground truthing; (NW G1); Intensive establishment – site relationships; Improved land productivity knowledge; Develop site productivity database (map based); Better understanding of the potential (NW G1) • Develop cull hazard rating system for Ontario linked to FEC/ELC - major yield impacts (SC G4); storability (SC G4)

Managed stand yield	• Managed vs. unmanaged (Science need for Data Gaps. Info re. existing data) (NE G5); G&Y inventory (managed yield curves) (NW G3); Managed stand G & Y info (NW G4); Move provincial G&Y program into all managed (especially IFM) stands using appropriate design/sampling protocols (NW G5) • Empirical managed stand yield curves (NW G1); Silviculture treatments effects (G&Y) (NW G1); plantation yields (NW G2) • Develop appropriate growth models to reflect your requirements for IFM i.e. multi-stored stands/various silvicultural inputs (NW G3); Program should assess all IFM practices (NW G5); Establish growth plots to assess potential for growth based on using IFM practices (i.e. - weed control, SIP, Improved stock, Etc.) (NW G5); Need to know long-term impacts of practices on G&Y so proper program can be selected (NE G2) • Establish reliable yield forecasts for treatment alternatives, develop accurate yield curves for all the various treatment alternatives that might be implemented across a full range of forest units and ecosites (NW G1) • Responses to thinning (species/ages); prediction of thinning effects on growth & yield quality; plantation cleaning – manual removal of intraspecific competition, stand density management for each cover type, PCT, CT & yield and quality (NW G2); Need growth and yield impacts of additive treatments on sites (NW G5) • Assess impact on growth of doing partial harvest/pre-harvest in natural stands (NW G5) • G&Y info from managed stands, PSPs? (NE G4); collect G&Y for treatments that have been done but no data collected (NW G1); Likely contributions of practices to volume – how do you quantify it? (SC G3) • Research into impact of trees produced by IFM practices on wood quality – all aspects (NW G5); Can black spruce be used as a sawlog species? (NE G1) • Will IFM practices negatively affect occurrence of cull, root rot diseases, butt rot? (NW G5)
Rigorous scientific approach	• Confidence in growth; Inventory Quality; CFI & Growth Project Models (NW G4) • Collect and assess quality of current baseline growth and yield data (NE G6); use appropriate design/ sampling protocols (NW G5); Use adaptive management to revisit, establish PSP's; Remeasurement of old trials, existing PSP's, Calibrate data from other jurisdictions (NW G1)

Appendix V. Policy

Issue	Comments
IFM Definition	• Develop glossary of IFM terms. In mixed stands, IFM could mean stand improvement. In high value conifer stands could mean pruning, may also refer to traditional tree improvement. • Must include requirement for monitoring (SC G2) and monetary (SC G5) input; improvement in stand and wood quality over time, and focus on sawlog (or higher quality) products (SC G2, 5) • IFM is just developing more expensive treatments to promote growth and better quality. There are ways of conducting IFM less expensively than other, more extreme, types of IFM. Not only financial return or cost comparison approaches by final expected yield should be considered. Some cheaper ways have good returns (NE G2)
Need for IFM	• What are some of the pros and cons of IFM? (NW G2) • Identify needs/issues (NW G3); clear management objectives for "the IFM zone" (NW G1); tools/models to provide necessary analysis (NW G3) • Have a positive/proactive approach (NW G3) • Is IFM a reasonable thing to do? What will it take? (NE G2) • There are lots of opportunities for increased forest output outside of IFM that we are presently not taking advantage of (NE G2) • IFM activities must be available to the overall land base — maybe special consideration on EMAs but generally activities are applicable everywhere (NE G2) • *Tree-farming* possible but has ecological impacts and may not be acceptable (SC G5). • Plan for the area; social/political factors may drive IFM (NW G3) • Best bets for IFM: conversion/site restoration (SC G6) • Private ownership to set new landowner value sets or attempt to meet all needs on all lands (NW G5)? • Impacts of IFM on forest health, forest sustainability (SC G2)
Develop IFM Strategy	• 'Gun shy' MNR culture is preventing IFM and adaptive management from happening! • Reluctance on part of industry to *openness and encouragement to do things that work* • Problem with designating a specific site on the land base in flexible land base perpetuity instead of deciding area that will be available annually or whatever period (NW G1) • Regional variation makes priorities disparate (NE G4) • Impediments - significant cost to localize, often require GIS, modelling, and forestry expertise to operate - haven't needed to use the models yet... (SC G7) • What are the barriers to applying existing knowledge? (NE G1) • Political 'situation' like spring bear hunt re herbicide • Research related to identifying limiting factors (NE G3)
Objectives	• Need a specific forest management strategy (direction) with clear objectives to identify why IFM is being done. Purpose is to provide SFLs direction and context for IFM. Province, as landowner, must manage the land base for the greatest (public) benefit • Objectives must be clear (SC G3, 6) • There are still questions on how to set objectives (SC G1) • Identify what is wanted (*i.e.*, objectives) (*e.g.*, increased quality, increased monetary value, increased volume) and then identify how to measure the outcomes (not as easy to do in southcentral as in boreal); objective identification and assessment in FMP (SC G2) • Management strategies and objectives of each SFL need to be consistent with provincial direction and expectations and be acceptable to Native community

LEGISLATION, REGULATION, POLICIES AND GUIDELINES

Issue	Comments
General	• Are there policies in place that restrict or limit the use of specific silviculture/ IFM practices? What practices are affected? Is it due to a lack of science or information? How can we correct the situation? (riparian zones, thinning, tree improvement) (NW G3, SC G7) • Need policies that support IFM – need commitment to IFM to avoid cutting programs that support science and technology development and testing and information transfer around IFM; furthermore, MNR and industry need to adopt the policy and make it **permanent** (SC G1) • Need flexibility, not rules, in application or interpretation of policies (NE G4) • Need MNR and forest industry to develop a *Forest Sector Strategy* clearly describing provincial expectations for timber supply and production. It should support the future forest industry like the 1972 Timber Production Policy that identified future industrial requirements by 2020 and put in place and funded silvicultural program to get there (NW G5) • Need 'agreements' on forest activities (and wood supply implications) to be performed on enhanced management areas and the intervening landscape. The original Accord was based on the assumption that wood supply would improve from these areas (*e.g.*, guideline review; low volume/quality stands; utilization; *etc.*); is this assumption still valid? If not, there is a larger problem to solve in better forest management *areas* (NW G5) • Science information and public opinion is changing much faster than our policy and direction (NW G4) • Need a policy for identifying Intensive Forestry Zones (NE G1) • Policy issue – more precise depth of concepts emerging from Accord re IFM (NW G5) • Need tools for silviculture prescriptions in intensive silviculture practices (NE G1) • Need more effective management policy on long-term management of degraded sites (SC G3) • Include stakeholders in policy development (First Nations, NGOs) (NE G1)
Challenges	• Policies interfering with IFM: too much info required; means of collection and presentation inappropriate; redundancy, too many and too complex silvicultural ground rules; red tape in reporting, planning, licensing, billing, scaling, etc.; fertilization, drainage, commercial thinning, exotics not considered in EA; pesticide use severely restricted; prescribed burning restricted; areas of concern and reserves inaccessible; lack of direction about genetically modified organisms; and excessive stumpage rates (SC G6) • Tree cutting bylaws endorse unsustainable practice of high grading and diameter limit cutting in tolerant hardwood forests — will negatively affect future AAC available to SFLs from private lands (SC G7) • Rigidity of implementation; CFSA and FMPM take away from site by site management (NW G3) • Existing system is too bureaucratic – it discourages innovation (SC G1) • Matching forest management with AAC: doesn't fit with biodiversity strategy the way it is currently implemented; issue around age class substitutions (ha by ha issue) (NE G3)
Exemptions and Exceptions	• Streamline exemption process (NW G4) • Change approach on "exceptions" — too onerous a process; key to adaptive management process (NE G3); excessive bureaucracy around trying something 'new' and having to pay for it; stifles innovation (*e.g.*, commercial thinning in jack pine) (NE G6) • Need for risk assessment, some exceptions more serious than others (NE G6) • Adaptive management approach needed to deal with exception (EA, process issues) • For exceptions (under EA) consider practices that are common in other jurisdictions differently than other generally untested or new silviculture approaches (NE G2)

Issue	Comments
Policy review and revision	• What existing policies and guidelines need to be changed? Why? (NE G6) • Changes to policy level in MNR re who does public consultation, etc.? (NE G6) • Rewrite Policy and Guidelines to accommodate adaptive management; how much data is needed to result in change of guideline? (NW G5) • Need for faster process to change legislation and/or guidelines; how can guidelines be made more dynamic; the present process is long and not responsive enough to change (SC G3) • Either changes or exceptions or more sensitive prescriptions should be allowed on enhance management areas to prevent rotation ages from being changed; that may influence return on investment (NE G2)
Environmental Assessment	• Harmonize timing of review of EA T&Cs with CFSA and FMPs (SC G2) • EA does allow for exemptions re thinning, tree improvement (NW G3) • Need a mechanism to implement practices not authorized in EA (NW G4) • EA review opportunity (NW G4)
Guidelines	• Enhance existing silviculture guidelines to include intensive management (NE G1) • Supposed to be continued improvement - guides become rules which lead to stagnation; limited new science (NE G4) • General guidelines (conservative; each written with a general approach/ application; broad brush (not integrated — need to integrate with desired future forest condition) (NE G4) • Divide guidelines into categories (advice guidelines; best practice; code of practice) (NE G3) • Make sure that guidelines and regulations match; find way to change regulations when science indicates • Enhance existing silviculture guidelines to include intensive management (NE G1) • Supposed to be continued improvement - guides become rules which lead to stagnation; limited new science (NE G4) • General guidelines (conservative; each written with a general approach/ application; broad brush (not integrated — need to integrate with desired future forest condition) (NE G4) • Divide guidelines into categories (advice guidelines; best practice; code of practice) (NE G3) • Make sure that guidelines and regulations match; find way to change regulations when science indicates need for change (SC G1) • Most guidelines allow some level of operation, however we need clear and acceptable prescriptions (e.g., water quality, riparian code of practices, cultural heritage guides, resource-based tourism, aesthetics) (NW G4) • Coordination between guidelines reviewers - impact on wood supply (NE G1) • Cumulative effect of guidelines – How do they interact? Are they contradictory? (SC G1) • IFM will ultimately conflict with existing proposed guidelines; will need to relax or revisit some of our existing guidelines (NW G3) • Need science involvement in guideline review (SC G1) • Ecosite-based guidelines for the management of black spruce, old pine, jack pine (NW G5) • Need revision to address managed/density regulated conditions (NW G5) • Revise process and make more operationally relevant (SC G1) • Need for consistent interpretation of guidelines across the range of application; would help with review and modification; would help resolve conflict between/among guidelines (NE G3) • Training issue regarding guidelines: need to consider a "certification" course on the interpretation and use of guidelines, + earn approach?, individual approach?, guideline theory and application, provincial vs. regional theory – gets at consistent implementation/interpretation (NE-G3) • Guideline effectiveness needs to be evaluated (not so much process but whether original intent accomplished) (NE G4) • Do all guidelines have to be applied on all areas or are some exempt for IFM (NE G5)

Issue	Comments
Guidelines (cont)	• Need more standards around physical disturbance guidelines – science required, modify to allow IFM to fit in with emulating natural disturbances (NE G5) • Emulating natural disturbance guidelines have to be reviewed and published; need to be fine tuned to address GLSL forest types – direction around emulating natural disturbance guidelines conflicts with EA on clearcut size (SC G1) • Revise tolerant hardwood guidelines to make markers/operators the same (NW G2); What is the necessity for marking ground rules? – Perhaps training directed at operators instead of separate marking crew (NW G1) • Need to understand the cumulative effect of FMP guidelines – what is the opportunity to amalgamate/collapse requirements? (SC G4)
Manuals	• MNR needs to revise the Forest Information Manual to make the following forest cover attributes mandatory to facilitate growth and yield modelling, land base description – not optional (Stand origin/history *e.g.* density regulation; partial harvest, commercial thinning, natural); density class; understory composition) (NW G5) • Revise FMP to make more operationally relevant and to encourage innovation (SC G1)
Silviculture Ground Rules	• Need to be modified; not currently suited for IFM (NE G1) • Silvicultural ground rules – already allows flexibility. Have to build flexibility into planning system (*i.e.*, adaptive management). We don't need more process; need to entrench adaptive management in practices (need transfer) with effective monitoring/feedback. Also need to develop tools for data collection. Need tech transfer (interpretation compendia). E.A. issue; conflicting *e.g.* woodland caribou –marten (NE G4)
Climate change	• Climate change and forest sustainability; invest in IFM? (NW G4)
Wood supply	• Understanding of mill requirements – how do we really know there is a wood supply shortage? (NE G5)
Economics	• Money should not be thrown at the initiative – managers should be choosy. IFM means more money invested – not just higher returns on existing investments. There are paths to higher returns other than IFM. It would be better to treat all sites at any level. Treating all sites at a basic level, or guaranteeing that all sites are fully stocked with desirable species, will do much to remove the need for IFM. Do the job right each and every time (NE G2) • For IFM to become a common practice there will have to be financial incentives for the SFLs or someone else will have to pay (NE G2) • Protection *vs.* wood supply and investment (NE G5); protection of investment in EMA's is not just for natural catastrophic events but social events also (NE G2) • Need incentives for companies *e.g.* tenure (NE G5); not being able to harvest the benefits of concern (tenure) (SC G6) • Established IFM EMAs must be delimited on the land base to protect the investment and allow long-term return (NE G2) • Make a new fund for IFM – add it to the stumpage fees or enhance existing system (NE G1) • Make investment in IFM more attractive to forest industry – create IFM working areas over the landscape – zoning, land use designation (NE G1) • Need science input into guidelines – where is the money? (SC G1) • Who's going to pay for IFM? – must be financially viable – shouldn't just do it because of Forest Accord (SC G2)

Issue	Comments
Economics (cont)	• Who pays for higher level of protection required on IFM areas? (NE G1) • Contractors should be supported through forest funds to acquire softer technologies and skills (SC G2) • Commitment from government for research - $, partnerships (SC G4) • Provide stumpage (other mechanisms?) relief on identified IFM areas where new and more expensive silviculture technology is being implemented by industry; how to accomplish without raising 'subsidization' question? (NW G1) • Policy re stumpage relief on IFM areas (NW G2) • Evaluate cost effectiveness of certain activities and equipment (harvester) i.e. drainage (NE G1)
Stocking and regeneration	• Policy for stocking and regeneration –currently minimum effort -need standards to assist planning teams – NSR standards need to be revisited (NE G5) • Ability to get natural regeneration of mid-tolerant species e.g., red oak, white pine (SC G7)
Certification	• Integration of criteria and indicators for certification and provincial forest management requirements – more time to do IFM – combining the FSC and FMP will also save money – can put it into IFM (SC G7)
Planning	• Better integration of FMU/FMP planning with landscape ecological planning (parks, adjust FMU's, wildlife, fire) (NW G4) • Where are we going to do IFM? (SC G2) • Tools need to be clearly defined to make planning more efficient (NE G1) • We have to be clear on the forest area that we are talking about, require agreement on where IFM or better forest management can be practiced (NW G5) • The issue is zones vs. criteria for identifying candidate areas in priority order (biological/economic/impacts on other value, etc.); build the prime site criteria and sign off on these when project complete (NW G5) • Planning – setting landscape-level composition (SC G1) • Better access needed for IFM (SC G6) • Front end FMP analysis being used as ecological benchmarks – are we confident in these results? Is the FMU/FMP the appropriate scale to determine these benchmarks *TPP Forest Sector Strategy* (NW G4) • Pre-Harvest Site Prescription (PHSP) possible requirement to promote IFM (NE G1) • Lengthen the planning cycle –helps IFM implementation – problems with changes during the preparation time – changing rules (NE G3) • Playing around with 1000 ha not big issue (NE G6) • Size of clearcut patches in GLSL (SC G1) • Geographically based tracking system for managed stands (SC G2)
Modelling/Yield Curves	• Predictive models are tools only – back to dangers of virtual volume, virtual populations and virtual values (NE G4) • Practitioners need field experience and training before they can use models/programs effectively (NE G4) • Need modelling systems that can import DSS from other provinces, places, etc. • More info on how to increase volume from treatments, e.g. tree marking (SC G5)

Issue	Comments
Silviculture guides	• Consider intensive management areas in terms of requirements, prescriptions, flexibility, trade offs (NW G1) • Optimize AOC prescriptions and update eagle/osprey guidelines (new science) (NW G4) • AOC guidelines restrict use of partial cutting systems (selection/shelterwood) – need more science/monitoring (SC G7). AOC guidelines that permit modification of outer zones - better definition of acceptable practice in modified zone (NE G3) • Habitat guidelines to be more flexible to recognize IFM (NW G2) • Reevaluate all guides which have spatial impacts which could affect IFM (marten, caribou) (NW G2) • Draft disturbance guidelines – include caribou, marten, moose, osprey, bald eagle, heron, white tail deer, etc. (NW G5) • Examine draft caribou guidelines to determine where and how IFM would function in this context will require research to assess impact on caribou populations (NW G5); Caribou mosaic/IFM conflict; rotations incompatible (NW G2) • Building marten core in areas that we'd like to apply IFM – in order to meet marten 10% minimum. Recognize IFM area as priority and part of rationalization for not meeting guidelines (NW G1) • Require update to reflect hierarchical approach (coarse filter approach) (NW G5) • Require clarity of decision nodes in the guides and the rationale of why it is important (NW G5) • Identify where the lack of information is in making specific decision nodes and provide direction to research, i.e. impact of caribou block disturbance on osprey/eagles/heron to harvest to immediate No Cut Zones *i.e.* 100-200 m, evaluation if bird simply left nest and went across to standing timber on other side of lake; comparison of adaptive ability of bird to move naturally if nest/tree falls down in a wind storm (NW G5) • Tools – identify alternate habitat or habitat design using features to optimize habitat suitability while maximizing fibre extraction (NW G5) • Policy – quality – 'forest health' and 'emulate nature' – CFSA (NW G5) • Guidelines related to IFM: marten habitat, immediate effect in the short-term (NE G1); Policies/Guidelines (marten guidelines) need to factor economics into application (NE G4) • Review guidelines around anything leading to reserves - science needed (SC G1) • Review moose aquatic feeding guidelines in GLSL (SC G1) • Need to test the biological assumptions that drive guidelines - e.g., habitat requirements of marten (SC G4) We don't know how to create good marten habitat. What kind of silviculture makes good marten habitat?
Prescribed burning and wildfire as a silvicultural tool	• Regulated burning conditions too restrictive (SC G7, NE G3); policy makes it too expensive (SC G6, SC G7), leads to lack of use (NE G3, SC G6) and decreased diversity of mid-tolerants (SC G7); alternatives needed when burning impossible; potential use of chemical for burn alternative (SC G6) • Rework guidelines to streamline the PB process (NW G4) • Revise prescribed burning guidelines and priority setting for GLSL (SC G1) • Review prescribed burn guidelines re planning and training for GLSL understory burns and cost (SC G1) • Prescribed burns in GLSL - delivery mechanism lacking - costly and uncertain; Planning process is onerous - why is time and amount of planning required for small Pb in SC same as for large one in boreal? (SC G2) • Review priority setting exercise around GLSL burns - ecological burns where wood harvested vs. not (SC G1) • Link to update Gen. Cons. Policy (NW G1) • Cost and liability shared equally (NW G2, 4) • Modify current policies/guidelines to take advantage of wild fire; i.e., manage wild fire (NW G1) • Modify policy re wildfire suppression in intensive suppression zone; i.e., direct some fires to achieve IFM objectives? (NW G2) • Explore policy/funding constraints; make public aware what is done with fire (NE G1) • Expand slash pile burning program (NE G3)

Issue	Comments
Harvesting within riparian zones - high-way corridors	• Reevaluate policy and guidelines for activities. All the science is there. It is more of a public education marketing issue (NW G1) • Modify guidelines on harvesting lake shorelines (elimination/reduction of lake reserves- Recent science suggests no lake reserves affecting water quality (NW G1) • Remove present discrepancies on harvest of highway reserves from district to district (NW G1) • Allow – need consistent policy in NW region (NW G2) • More specific direction/requirements needed on harvesting in reserve areas. Possibly more flexibility here to be more attractive to IFM (NW G1) • IFM of riparian reserves, revise fish habitat guidelines - MNR taking full responsibility ($/staff) for critical fish habitat identification (NW G1) • Should be some flexibility to allow harvest in buffer zones (NW G1) • Conduct research in a range of stand types to determine manner in which harvesting can be conducted in riparian reserves while protecting aquatic and fisheries habitat (NW G5) • Revise guidelines accordingly to permit harvest – but often not done (NW G5) • Modify – riparian guides and water quality to allow harvest and prescribed burns to shoreline as a natural event without requiring a complete lake survey or necessarily having critical fish habitat info for this or modified harvest to occur (NW G2, 5) • Recognition of maintaining fire origin ecosystems in riparian areas and harvesting being an accepted and preferred tool(NW G5)
Thinning	• Establish program to assess impacts of PCT and CT on yield curves for major species in Ontario (NW G5) • Produce guidelines that are incentives to thinning - flow through shares - stumpage decreasing (NE G5) • Change commercial thinning to a 'recommended' practice in silviculture guides (NW G1) • Policy - charge for crop tree damage when thinning – PCT, CT, selection harvest (SC G4)
Vegetation/Pest Management	• Change policy re use of herbicide mixes (NW G1, 2) • Review pesticide guidelines to see if we can increase options (SC G1) • Biological insecticides only - no tools for non-lepidopteran (e.g., sawflies) can't use mimic for budworm therefore reduced opportunity for early intervention (SC G7)

Issue	Comments
Protection	• We require legislation and policies to ensure access to the appropriate tools to deal with insects and disease (NW G5) • Protection measures: fire monitoring is adequate; insect or disease monitoring is poor; data collection needs to provide learning - sound science; be more intensive; two-level monitoring - extensive early warning; stronger link-survey; incorporate into G and Y work (NW G4) • Guidelines for sites at risk of damage - repairs required and standards (NE G5) • Protection guidelines -protection reduction vs. react to outbreak -no obligation to harvest in salvage areas (NE G5) • Need to develop a fire/disease protection plan and identifies who pays or develop some kind of insurance pot into which everyone pays (SC G2) • Policies and guidelines to support protection from insects: Neighbours not doing minimal level of management; Science need - What is influence of neighbouring populations on IFM success?; Policy need - legislation to force neighbours to manage at minimum level (SC G5)
MONITORING Develop a Strategy	• Key indicator monitoring necessary to measure progress towards achievement of objectives. Must monitor/ evaluate tracking performance on deliverables at all levels up to province; Ensure management information systems track treatment results to make better decisions. • Useful to have Decision Support Systems (DSS)/Expert Systems to provide land managers with tool set for immediate use in deciding where and how to implement IFM. DSS also provides framework for deciding what data is available and what additional information (research) is needed • Cycle: knowledge-planning-practice-monitor-evaluation-knowledge.... (NE G4) • Effective monitoring - develop baseline and create database (NE G1) • Provincial structure for collecting info re monitoring and feed back info (NE G6) • Monitoring should be occurring on all projects, anyway – don't make it a hurdle – make it a feedback loop (NE G2) • Coordinate (geography/program areas) effective and efficient monitoring program, tailor made potential effects i.e. answer the C/R or N/R concerns (NW G4) • Terrestrial assessment units; effective, efficient; multi objectives/use of data; common standards; need to design with so what questions (NE G4) • Answer the question – what are you monitoring for? (NE G6) • Monitoring/Evaluation (need efficient effective; link with research (intensive) and extensive (landscape); cost effectiveness; feedback loop; provincial structure; stronger link with G and Y (interpretation) (NE- Overall Summary) • Tools to identify what the future forest condition should be (SC G1) • Regional standards for monitoring C+I (NE G1)
Full Cycle Planning	• Make sure it is more integrated for all activities (SC-G7) • Need format or template for full cycle planning (amalgamation of existing FMP tables) (SC G7)

Issue	Comments
Silvicultural Effectiveness Monitoring (SEM)	• MNR and forest industry need to jointly establish, maintain and report on a silviculture effectiveness data base stratified by ecological condition/ administrative areas – *Stewardship Role* (NW G5) • Silvicultural Effectiveness Monitoring (SEM) (NE G5, NW G4) Syntheses of existing data first (NW-G4) • Projection models in continuous forest inventory (CFI) (calibrate existing info; revisit computing power; SEM) (NW G4) • Need to do monitoring/evaluation of existing Intensive Silviculture -record keeping (NE G4) • Effectiveness monitoring – finish the mgmt. loop! Evaluation (SCG3)
Exception Monitoring	• Monitoring of exceptions (NE G3) • Means to value exceptions (NE G3) • IFM prescription standard monitoring plan if exceptions (NW G4) • Keep it stayed or stepped for different levels of exceptions and currently reviewed practices (NE G2)
SELECTING IFM AREAS General	• Incomplete provincial ecological inventory and lack of quantification of timber/ non-timber values for polygons (multiple scales) suggest that completion of an accurate, precise, up-to-date, spatial ecological inventory (ecosite-based) would be valuable. If adopted, it would be essential to commit to maintain the precision, accuracy and history of the inventory database (NW G1) • Need criteria to use to establish intensive management 'zones' vs. identifying as zones on a map (NW G5) • Define landbase on which you can practice IFM (SC G3) • Determine how much and where, how much area is required to meet the shortfall? (NE-G1) • Identify the best sites (NE G1); prime site identification (NE G1, 3, 5, SC G6); prime land mgt and identification (NE G4); prime land classification (NW G2); prime land vs. prime site (NW G5) • Identify boundaries for intensively managed areas (SC G2); make sound decisions for where to practice IFM (SC G3) • What is an appropriate proportion of the land base to have in "fibre farm"-level IFM in terms of landscape scales (SC G3) • Landscape-level information critical to identify areas of concern but needs to go down to MU level eventually; Landscape level not refined enough as is (SC G7) • Use landscape models to help identify sites for intensive management, fill data gaps in soils maps (SC G4) • Pre-id areas that show economic potential for the increased investment. Need to know expected results or cost levels in relation to transportation costs and mill location (NE G2) • Proximity of management action to mill or end user will be important in determining the value or feasibility of proposed IFM (NE G2); may be best site, but might be too far away (NE G3) • Pick sites free from multiple use conflict (NE G2) • Need landscape planning tools (NW-G5) • GIS should be used to identify and map IFM area (NW G1) • Would you use landscape level info to assist in selecting IFM areas? Are there gaps in the present info? What are they? (NW G3) • Plantations - Where should we have it? Private land (SC G1) • Strategic analysis of the best locations to consider applying IFM (SC G4)

Issue	Comments
Tactics	• Commitment of resources to complete new inventory; Evaluate regional candidates for IFM – prime sites (near mill & high productivity) for black spruce and jack pine; not good for IFM (conflicts, poor productivity) (NW G1) • Complete prime land mapping exercise for Ontario (SC G4) • Need to use landscape-level GIS analysis at the management-unit level to more specifically define the problem (i.e., where is the wood supply shortfall, are there any prime sites with potential as enhanced management areas). Evaluate intensive silvicultural options to determine the best bang for the buck, then determine specific science needs required to implement those silvicultural options (SC G7) • Reforestation of abandoned farm land (Hwy 11 corridor) (NE G3) • Determine criteria for site selection based on existing forest protection tools (SC G3) • Inventory of abandoned marginal farmland – potentially available for IFM – *info. needed* (SC G3); Land-base reductions for forestry (SC G6) • Develop a GIS model to identify large tracts of available marginal agricultural land that could be afforested (inc. forest cover, size of average forest, etc.) (SC G7) • Rehabilitation of brush land – forest tree species (NE G3) • Look at focussing investment on current degraded sites – these are high productive sites that with some remedial silviculture could produce a lot of fibre (NE G2) • Focussing IFM on small blocks (NE G5)
Solution	• Mapped "site" descriptions • Inventory tracking – long term; Inventory timber • Ecological (FEC/ELC), spatial (maps) • Prime site evaluation/inventory • Recognize and identify eco-region constraints and opportunities; • Capability tomanipulate and organize data (NW G1) • Develop a forest- and stand-level decision support system or classification to determine areas suitable for IFM (NE G6) • Determine (through landowner survey, GIS analysis, analysis of G & Y plot data) best areas in region to apply single-tree selection to realize greatest gains in quantity and quality of sawlogs (SC G7

EDUCATION, COMMUNICATION, TRANSFER AND TRAINING

Issue	Comments
General	• Which IFM practices require training, certification or licensing? Crop planning (landscape, stand level down to individual tree); PCT training/certification; Tree marking needs to be enhanced (raise standard) (NW G3)
Public education	• Need science/policy for public education (SC G6)
Training	• Need training standards (NW G3) • How do we develop and maintain a competent labour force? (SC G2) • Trained and skilled practitioners (NW G1) • Need to develop silviculturalist training towards customizing a crop planning approach for Ontario and economic analysis of practices • Need to have harvesters and silviculturalists trained and in forest together (NW G3) • Support and training for Canadian operators -look to Finland for help (NE G1) • Need to provide training programs to reduce logging damage; set of rules to give Silviculture Foreman on site • Staff training / competency (down to operator level) (NW G4, SC G6) • Develop clear parameters for competency and level field between government and industry as far as training goes (SC G3) • Forest worker certification (SC G4) • Careful logging operator training/certification (SC G4) • Educate operators in the intent of partial harvesting systems (SC G4) • Increased auditing of tree marking course - longer training - all aspects e.g., group selection (SC G4) • Operator training and stability of staff (NW G4) • Training in ecosite management (NW G3) • Training for thinning • Communication and training around use of density management diagrams (NE G5) • Targeted training for medium and small contractors on basic forest principles (specifically allocated) (SC G3) • Train operators to be decision makers - which trees to cut and which to leave without marking (SC G3) • Education, training but recognize human judgement (SC G6)
Careful logging	• Careful logging expertise (NW G1) • Training/certification - Careful logging (SC G6) • Certification licensing -operators regarding: CLAAG, sensitive sites • Accelerate professional forest worker development (SC G6) • Focus on safety, careful logging and understanding the forest (SC G6) • Training materials are available internationally, translation required, more Ontario-specific information required (SC G6) • Human resources to operate equipment getting difficult to find/train (SC G7) • Improving competency of IFM workers to cover many IFM activities - stabilize workforce. ID skills sets; ID training needs; develop program (SC G7) • Need to evaluate equipment and training on the basis of the nature of the forest the machine technology was developed in (SC G7) • Uniform forest surveying methods training for field staff to ensure accuracy and dependability (NE G1) • Soil/ecology training for individual stands -draw from existing FEC knowledge experience (spruce falls) (NE G1)

Issue	Comments
Technology Transfer	• Must be a policy regarding 'instant' technology transfer of IFM info as it develops to field practitioners – *researchers cannot sit on their work*; Synthesis and transfer of existing knowledge (i.e. lit review, old trials, etc.); Build on existing IFM knowledge through technology transfer, extension and demonstration areas (Industry and MNR) (NW G1) • Refocus STTU's, supported by research units (client driven); Calibration and operational testing of 'science' from elsewhere; Literature reviews of specific topics; Establish demonstration areas; Exchanges of staff, workshops, field tours, and Admin. structure allowing for joint industry/MNR funding (NW G1) • Improved responsiveness includes GIS info (NW G2) • Tech transfer work on identifying science work on restoring – Pw; mid-tolerant hardwoods; He (SC G1) • Need transfer technology/info for existing machines (SC G3) • Training and transfer to identify stands for restoration (SC G1) • Improve F.I.D.s data and data transfer to practitioners (NW G2) • Need more transfer on careful logging in selection and shelterwood situations and associated tree marking (SC G2) • Need more information about hand herbicide tending applications (SC G2) • Transfer US removal cut training program - relates to CLAAG, HARP, etc. (SC G2) • Integrate/evaluate all aspects of IFM follow-up - tech transfer (NE G4) • Other possibilities: Motor-manual brushsaw simulation; Robotics - Jacob's ladder; chemical/motor-manual treatments
Communication	• Communicate widely why you are using IFM and decision that was made as a 'starting point' (NE G6) • Informed public should be aware of all policies (SC G3) • Industry and NGOs need to deliver/communicate messages together; communicate 'strategically' – choose target audiences – *deal with the mistrust* • Communicate results not the 'intensity' - more productive use of crown land!; communicate successes at local level (NE G6) • Ask academic community – get them involved (NE G6) • IFM dialogue needs to continue (SC G1) • Communicate what IFM is to the public (SC 1, 2, 3); develop public support, understanding, and acceptance of IFM prior to implementing (SC G3); develop a communication/marketing plan directed at urban populations (SC G4) • Provide information to public up-front about what IFM areas will look like and how they will develop (SC G4); communication process - sell or not sell key to success (SC 1,2) • Develop an Ontario-based regular science newsletter that covers what everyone is doing and how to contact (SC G2) • Develop an information and knowledge sharing and transfer/training network within and among SFLs/MNR/ etc. (SC G2) • Need better communication with federal counterparts (CFS, CFIA) • Need public communication around protection options (SC G2) • Marketing/communications strategy on any/all changes - global level (NW G1) • All information to public except industrial competitive proprietary; it may be a challenge to identify the proprietary stuff! (SC G4) • Information about multiple use philosophy (SC 1,2) • Survey SFLs about how to make up wood shortfalls (restoration); need communications strategy and communicators (SC G6)

Appendix VI. Protection

FIRE

Concern	Comments
General	• Ontario should increase its use of fire (prescribed burn) in forest management for the benefit of forest health and prevention of high intensity forest fires (NW G5) • Are current protection measures sufficient? (NW G3) • What science and information needs are lacking? (NW G3, NE G6)
Knowledge	• Specialist in the field of fire ecology and management (NW G5) • In-depth knowledge of fire patterns, dangers, and prevention (NW G5)
Tools	• Spatial fire management system (CFS) used to monitor/predict fire danger/behaviour (NW G5) • "RMS Dispatch" (BC Forest Service - A real time fire and resource monitoring system for efficient fire management and resource decisions) (NW G4,5) • CFS Pacific Forest Centre (Brad Hawkes) - Fire prediction and modelling of fire ignition and behaviour (NW G5) • More responsive MNR fire organization (catch fires when small) (NW G2) • Fire history maps and core samples of lake sediment (NE G3, NW G1) • New equipment - salvage of burned timber, more controlled understory burns and stand replacement burns - burn susceptible areas now rather than later (NE G3)
Policies and Guidelines	• More allowance for burn policy in forest parks and crown land (NW G4,5, NE G6) • Safe fuel load standards (NE G6, NW G1, NE G5) • Fire management planning in forest operations (NW G4, G1) • Modify current guidelines to take advantage of wild fire as a silvicultural tool (NW G1,2) • Recognize the values associated with IFM investment vs $500 trapper's cabin (NW G2,4) • At stand-level, look at species composition - insect interactions; species comp - fire interaction; 2-stage harvest effects on fuel, windthrow, snow damage, pathogens; and salvage effect on future stand development opportunities (NW G4)

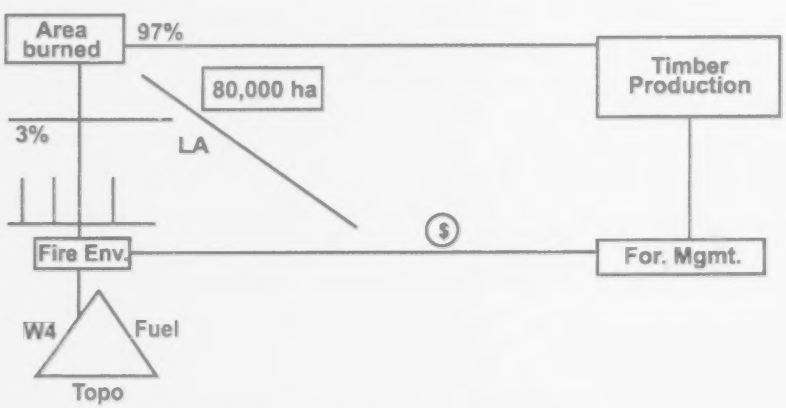

Figure: Schematic re fire and regeneration

INSECTS

Concern	Comments
General	• Synthesis for insect and disease effects of alternative methods of control (SC G6)
Knowledge	• Is it possible to develop a forest that is resistant to insects, disease, or fire?(NW G3) • Develop and test biological control measures for insects and disease in boreal forests (NW G1) • Develop effective, practical means to protect white pine regenerated sites (high cost investment, high value) from blister rust and weevil (NW G5, NE G1, SC G1,2,3) • Research socially acceptable insecticides and conditions for use (NE G3, SC G5,6) • Insect protection methodologies and understanding biological process (SC-G5) • Tree improvement and plantations may increase exposure to exotic pests (NW G1, SC G2) • Need more information about non-chemical protection options (SC G2,4,5, NE G5)
Tools	• Must have enhanced protection and early detection for insects, fire, and disease (NE G3) • Pick areas that landscape can naturally protect (NW G4, NE G4) • Integrated pest management for native and exotic insects and disease (NW G1, SC G2) • Need public awareness around protection options (SC G2,4, NW G4) • Pest control application equipment designed for site characteristics (SC G3,4) • Inventory of potential pest problems and available tools/products (SC G5, NE G5) • Pesticide registrations for minor pests and alternative control products (SC G4)
Policies & Guidelines	• Evaluate level of risk for different silvicultural activities (NE G1,3, NW G1) • Enhanced protection in IFM areas in management plans (NE G3,4,5) • Cross reference and a summary of "thumb rules" by harvest strategy, forest unit, sub-region (for the field) -- existing guidelines too massive to take in the field (SC G3)

DISEASE Concern	Comments
Knowledge	• Guidelines/code of practice: need to have an impact statement/analysis (NE G3) • Determine true health of forest as it applies to predicting blowdown, root rot and other diseases, insect damage, and fire (NW G1,5, NE G3) • Conduct risk assessment of IFM area susceptibility to natural disturbances (NE G3,5) • Relationship between intensity of management and incidence of pests and disease (SC G2) • How to deal with exotic tree pathogens? Currently no real management options (SC G2) • Better monitoring efforts and communication with Federal agencies (CFS and CFIA) (NE G5, SC G2) • More training for forest workers in identification (NE G3,5, SC G2) • Effects of climate change (SC G5)
Tools	• Expand and enhance pest management "FIDS' surveys (NW G1) • Improve "FIDS' data and data transfer to practitioners (SC G3) • Early warning system for SBW required (i.e., pheromone traps) (NW G2) • Methods for forecasting and monitoring infestations (treatment/protection, predictive models) (NE G5) • Better data acquisition and use of decision and support systems for single tree mortality and blowdown; current detection system doesn't pick these up well (NE G3) • Silviculture practices to minimize susceptibility to insects and disease (N3 G3) • Increased use of remote sensing to detect insects/fire/disease (NE G4) • Need inventory of potential pest problems and available tools (NW G5)
Policies and Guidelines	• Quality - 'forest health' and 'emulate nature' - CFSA? (NW G5) • Direct forest practices and write management plan to capture losses to insects, fire (NE G4) • Identify areas for increased protection corresponding to level of investment (NW G4)

Appendix VII. Social, Economic, and Environmental Concerns

SOCIAL

Concern	Comments
General	• We recognize that we do not know a lot about the social dimension of IFM; additional work is required • We also need to recognize that we are unaware of some of the implications of IFM to various people and communities in Ontario and elsewhere • Do not have the tools/models necessary for analysis? (NW G3) • Conduct a landowner survey to enable us to: obtain an inventory of where IFM may be practiced (SC G7, G3), understand landowner objectives and needs (SC G7)
Definition	• Clearly identify what IFM is and what it is not (NW G3, SC G1, 2), without clear definition, public opposition can be expected, as some practices are controversial • IFM education and marketing programs directed at the public (SC G1, 2, 4, NE G2, 3, NW G1) • Develop IFM practices that are compatible with public expectations • Describe the positive and negative consequences of IFM; for example, the consequences of restoring trees to abandoned farm land or increased use of herbicides (SC G1, 2, NE G4)
Marketing	• All forestry information (other than proprietary) should be made available to the public (SC G4) • Public concerns should be studied (NW G3, NE G3)
Technology Transfer	• Forestry staff need to receive continuing education and skills training on IFM practices (NW G4) • A full spectrum of technology transfer effort is required (SC G1,6, NW G4)
Protection	• Public expectations and concerns may limit the use of let-burn policies (NW G5) • Understand and manage public expectations regarding the use of pesticides (NW G4, SC G2) • Develop new methods that are compatible with public expectations to manage pests (NE G3, SC G2)
Biodiversity	• There is a concern that IFM will simplify forest composition and structure. This will have negative implications in the natural and consumer environments (NW G1, 4, NE G1,3, SC G1,2)
Economics	• Who benefits from and who pays for IFM? (NW G5, SC G3)
Labour	• Need to create a trained labour force (NW G4) • Certification systems could be used to recognize trained people • Forestry staff need training to explain IFM to the public (NE G4)
Aboriginal	• Need to gain First Nation acceptance of IFM (NW G3, NE G2) • Recognize aboriginal resource values (NE G4)
Rural Communities	• Develop tools to allow forest managers to assess implications of different strategies on subsistence use of resources (SC G1,2) • Recognize the economic benefits and ensure that First Nation and rural communities are able to share in them
NGOs	• Continued need to keep working with NGO partners (NE G6, NW G3)

ECONOMICS

Concern	Comments
Cost/benefit analysis	• Quantity vs. quality of various alternatives (NW G3) • Studies on PCT of different densities (NW G5) • Why pays for/who benefits from intensive silviculture? (NW G1) • Find opportunities for cost/benefits (NW G2) • Basic cost/benefit analysis of the complete range of IFM options to further refine opportunities (NW G3) • Decreased cost and increased value = increased social economic benefits (NW G3) • Cost involved in IFM - transportation, labour, silviculture - Who pays? Who benefits? - industry (tenure and ACE), government (opportunity for other uses and areas - social benefit) (NW G4) • Concern - without long-term analysis of the effects of IFM can we actually do cost/benefit analysis? - we may be able to get short-term economic stability but only at long-term environmental cost (NW G5) • Crown should share costs, given the benefits accruing it - revenue now and in future, parks, economics (NW G5) • Establish range of acceptable tools/methods to be used to complete cost/benefit analysis for IFM projects when applying for public or trust fund dollars (NW G5) • Trouble funding a basic level - how do we justify IFM? (NW G3) • Need cost/benefit of silvicultural treatments (additive) (NW G5) • Cost/benefit analysis of tamarack plantations (NE G1) • When doing IFM, is there a positive return? (NE G1) • Long-term monitoring of cost/benefit ratios - calibration of models (NE G3) • More cost effective means of achieving silvicultural targets! (NE G2) • Who pays? Who gets benefits? (NE G3)
Investment	• Access to Forestry Futures Trust Fund: intensive silviculture as eligible expense, prove link to wood supply (NW G1) • Investment must be protected or compensated (NW G2) • Who is paying? (no net increase in cost - stumpage) - value for monies being paid already i.e. $0.38? (NW G2) • Analysis of basic intensive forest management investment opportunities (NW G3) • Develop economic analysis strategy agreed to by province/industry/public to outline investment metrics and who pays for what (NW G5) • Require a financial process to make it attractive for private industry to invest in public land (public realizes the benefits of investment in its resource for free!) (NE G2) • Will the southern Ontario majority see the need to invest in IFM as forestry community does? (NE G2) • Economic ($) returns of IFM? (SC G6) • Does it make financial sense, based on return on investment to practice IFM everywhere in the area of the undertaking? (SC G3) • Can you make a business case for IFM? If not, who pays? (SC G4) • Develop value-added products to enhance return on investment (SC G4) • How do incremental IFM expenditures accrue to those who spent $? (SC G3) • Who should make the investment in IFM? It is assumed that industry should because it gets the fibre, but there are other benefits, e.g., maintaining mill-dependant communities, so perhaps Ontario as a society has some fiscal responsibility for IFM (SC G3)

Concern	Comments
Allowable cut, wood supply	• Allowable cut is a concern. Increase cut now in the hopes of reaping benefits of IFM later on? (NE G3) • Benefit comes after the work is done. Make sure the benefit is there before it is realized (NE G3) • What is the effect of IFM on wood supply (short-term, long-term)? (NE G3) • Clarify "no net increase in the cost of wood delivered to the mill" and "unless agreed upon to the satisfaction of all parties" - what do they really mean in the Accord? (NW G5)
Wood flow	• Reduce costs by rationalizing wood flows between licenses "just-in-time" (SC 1,2)
Products	• Specific product objectives need to be developed by management unit and species and corresponding value to industry determined (NE G2) • Do we know the balance of products (fibre vs. logs vs. other) that our treatments produce? (SC 1,2)
Social	• Should be increased employment opportunities as a result of IFM (NW G2) • Provincial government funding; increase in stumpage revenues, possibly less road construction (NE G1) • Must be able to put a value on social values. May have to help industry fund IFM practices if there are social gains to be realized and we do not wish to regulate IFM (NE G3) • Do business case on cost and social benefits (SC G4)
Economic analysis	• Decision support systems to guide economic analysis and IFM planning (NW G3) • Need tool that helps industry and government to allocate resources to best meet economic/resource objectives - get the most from the money spent - risk management framework for IFM areas (NW G5) • Need tools to assist QuickSilver-type models (NW G5) • Economic tasks to assess benefits of various gains across the landscape (NW G5) • Economic evaluation required for prioritization (NE G4) • Good economic analysis requires reliable forecasts of growth and yield effects of treatments (NE G2) • Optimization of resources (NE G4) • Evaluate the cost of status quo in models (NE G4) • Forecast realistic bounds on future standing timber values (NE G4) • Economic model - do unless harmful (different view of precautionary principle) (NE G4) • Develop economic models that reflect other forest values, include wood quality in analysis (SC G2) • Full-cost accounting for different IFM practices (include environmental/social costs) (SC 1,2) • Do we have / know the costs of treatments to do the economic analysis? What do we need to know? (SC 1,2) • At what point do adoption of various IFM practices make, or not make, sense economically? (SC G3) • Real cost of silviculture investment over duration of rotation (i.e. effects of interest rate) (SC G3) • Strategic allocation of limited investment (decision tools). Add economic layer to Dave Baldwin and Aji Perera's work (SC G3) • Need knowledge base so that we can predict product markets (SC G5,7) • Long-term outcomes uncertain (SC G6) • Economics of applying treatments - treatments series - models for short- and long-term products (SC G2)

Concern	Comments
Site productivity	• Need criteria for treatment implementation - IFM applied to areas with best economic gains that meet overall resource objectives (NW G5) • Summarize costs of silvicultural options by site type (NE G4) • Benefit of using more productive southern Ontario sites? (SC 1,2) • Need stand-level economics information to justify treatments in various stands (SC G2)
Environmental effects	• What is the cost of biodiversity conservation? (NE G4)
Policy	• If we have responsibility for the resource - are we managing the resource (best for the resource) or are we managing for another objective? (NE G2) • Increased risk through monoculture (insect infestation, natural disturbance) needs science information, depends on some rules in place; e.g., will pesticides be an option? (SC G3) • Incentives for IFM: tax changes (timing), NAFTA problems; look at tax incentive effects, part of public / private partner (SC G5,7) • Who pays and for how long? (SC G6)
Data requirements	• Everything funded under OLL will have a common database destination - common linkages, e.g., common ways of describing site - requires database coordinator (SC G5,7) • Need to set standards for information collection (SC G5,7) • Strategic database needed (SC G6)

ENVIRONMENTAL IMPACTS AND SUSTAINABILITY

Concern	Comments
Scale	• Impact of IFM will depend on the size and spatial distribution (geographic and by site/habitat type) of IFM areas (NW G1, NE G3, SC G5,6,7), expressed at multiple spatial scales (stand, landscape, etc.), and vary with time frame of reference (NW G1, SC G3,6) • Impacts may be experienced on adjacent lands and intervening landscape (NE G3, SC G3), and will vary regionally (SC G5,7) • Science directed to examine effects of IFM should focus at various scales (NW G5, NE G6, SC G3,6) • Assessment of the effects of IFM on ecological values for development of provincial forest policies should occur at the landscape level (NW G5) • Inventory, monitoring, assessment, and reporting needed (SC G4)
Non-timber values	• What are the long-term ecological impacts of IFM? (NE G1) • There is great concern that natural conditions (structure, disturbance) are not duplicated in IFM stands (NW G5, NE G2, SC G1,2,5,7), but many natural forest types in Ontario have very low structural diversity (NW G5); Will ecosystem simplification through IFM has negative ecological impacts, and if so, what are the costs of ecosystem simplification in terms of sustainability? (NW G5, NE G3, SC G1,2,3,4) • Research to address IFM effects on non-timber resources at stand to landscape level is needed (NE G5,6); research should have clearly defined objectives and focus (e.g., water, biodiversity) to determine the extent to which forest management intensity can be increased without sacrificing sustainability (NW G5, SC G1,2) • Research to test biological assumptions of guidelines (SC G4); benchmark non-timber values (NW G3), and criteria and indicators will be needed to determine the effectiveness of IFM (NE G6) and identify threshold for loss of sustainability and non-timber values (NE G3, SC G1,2). Develop method and collect data to quantify value of non-timber resources (NW G5)
Wildlife	• Establish baseline wildlife habitat and populations data for non-commercial and commercial species allows identification of critical threshold values for habitat and influence of forest practices vs. other practices on population levels (NW G5, NE G4, SC G5,7) • Better knowledge of marten habitat, i.e., wider criteria for suitable habitat (NE G2,4) • What wildlife are associated with various stand types ? extensive vs. intensive silviculture? (NW G5, NE G3, SC G1,2) • What combination of extensive and basic management could provide us with the timber we need for both timber and wildlife or all objectives? (NE G2) • Understanding of how "shifting mosaic of IFM" activities affects wildlife habitat or other values (NW G5) • Wildlife management vs IFM (myth busting). Evaluation of IFM areas for wildlife habitat use should be done to dispel myth of plantations being biological deserts (NW G2,4, NE G2); Need studies to determine if IFM really has a negative impact on wildlife management objectives and if it does are there IFM practices that can meet both goals? (NW G2, NE G2); does IFM emulate natural disturbance? (NW G1) Need to understand the relationship between structure developed via age vs. developed via management (NE G4) • Understanding relationship of pre-commercial thinning and other IFM practices to wildlife habitat and populations (NW G5); where , to what extent, and for how long will this and other IS practices affect wildlife habitat and populations (NW G1, NE G1,4, SC 1,2,6); determine cost/benefit (NE G1); IFM may increase total benefits i.e. diversity of wildlife for trapping (NW G1) • Wildlife. Watts talk- Guarantee vs quality; Large trees, uneven age (NE G4) • Better predictions of spatial distribution and abundance of wildlife- provides more effective reserves, How do we determine if reserves for wildlife are meeting their intended purpose - both now and in the future (NE G4)

Concern	Comments
Wildlife *(con't)*	• Monitoring of wildlife that ties into multi-scale modelling (NE G4); Need more wildlife population viability modelling tied to FRI-type data and life history data/information (NE G4); need sound scientific data to set parameters of models and species/habitat requirements (SC G4); Need habitat models for species requirements (NW G5) • Adapt existing DSS tools to IFM practices; use monitoring with adaptive management (NE G1) • Wildlife: Prove it (Watt's talk) - minimize use of precautionary principle (NE G4) • Endangered species management (SC G7); need inventory on endangered species - where are they and what are they (SC G7); habitat requirements of endangered species (SC G7); monitoring sensitive species (SC G5,7); Need relationship of rare, threatened and endangered species/stands to sites with potential to be managed under IFM (NW G5)
Biodiversity	• IFM is not natural - associated with low biodiversity, monoculture, effects on long-term site productivity (NW G1,4); diversity vs productivity (SC G6) • We feel we can have IFM without sterile, non-diverse mono-cultures - we can provide for diversity within and across, and provide habitat. We need the trials to show this. (NE G2) • Relationship between long-term protected areas and management of intervening landscape - how will long-term protected areas be managed and how will this affect management on the intervening landscapes (biodiversity and landscape scale) (NE G3) • Diversity maintained across the landscape (NE G2); effects of fragmentation on diversity (science need) (SC 1,2); include biodiversity in general and impact on physical part of ecosystem (NE G3) • Will IFM treatments achieve/maintain/emulate natural ecosystems by which performance of acheving biodiversity is based? (NW G5, SC G3) • Understanding large scale impacts of IFM on other values (NW G1); Need alpha and beta diversity in natural and managed IFM stands (NW G5) • Develop IFM practices which maintain/enhance biodiversity (NE G1); Benchmark biodiversity to ensure acceptability; Ensure effects on flora and fauna are well documented/researched (NW G3) • Must take into account inter-relationships between biological processes occurring on: IFM area, Extensively managed area, Buffer areas, Parks and protected area (NW G1) • Need to do spatial analysis of availability of prime land by management unit - will give a sense of diversity impacts, a sense that there is a shortage of prime land therefore no need to get bogged down in cost-benefit analysis (NW G5) • Monitor/predict implications of IFM on biodiversity at species (stand), genetic, and landscape level (NW G1); successional models (NW G3)
Soil/site Productivity	• Assess present knowledge in IFM for potential to predict long-term environmental and ecological effects; develop long-term information gathering and analysis systems of effects on the environmental changes and on ecosystems and their inhabitants controlled experiments, baseline information, change information at macro- and microsite level (NW G5) • Impacts research to assess long-term impact of IFM and associated equipment (NE G1,3) on long-term productivity and soil carbon cycling and its variation with site type; assess impacts on aquatic and terrestrial environments (NW G5) • Long-term site productivity research should focus on shallow soil sites and nutrient-poor sites treated at a range of IFM intensities (NE G1)

Concern	Comments
Soil/site productivity *(con't)*	• Impacts of fire suppression (protection) and decreased use of prescribed burning on productivity? (NW G5, NE G1) • Impacts research to identify methods to ameliorate negative effects on site productivity (NW G5), develop decision-support tools to assist FMP process in protection of physical environment (NW G5, NE G1, SC G3) and site sensitivity rankings (NW G5) • Monitor the impacts of IFM and increased utilization (e.g., full tree harvesting) on nutrient cycling and long-term productivity (SC G1,2,3,4)
Water quality/ quantity	• Examine IFM effects on water quality (MOE standards) (SC G1,2,5,7) • Assess impacts at the landscape level to reduce overall impact (NE G1), as IFM moves closer to communities, water quality of communities may become a local issue (NE G6) • Impacts of IFM practices (e.g., nitrogen fertilization) on aquatic species (SC G5,7), watershed hydrology and nutrient cycling at stand level (NE G1) • Impacts of partial harvesting in riparian buffers? (NE G1); training with modern technology to operate in riparian areas (NE G1) • If IFM means larger cut blocks closer to mills, may deactivate roads and, therefore avoid the problems of sediment, etc. with road building (NE G6)